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(12) United States Patent
Higgins

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(54) **AQUAPONICS SYSTEM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 407 days.

(21) Appl. No.: **14/254,446**

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(65) **Prior Publication Data**

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(51) **Int. Cl.**

A01G 31/02 (2006.01)
A01G 25/00 (2006.01)
A01G 9/02 (2018.01)
A01G 31/06 (2006.01)
A01K 61/10 (2017.01)

(52) **U.S. Cl.**

CPC ***A01G 31/06*** (2013.01); ***A01K 61/10*** (2017.01); *Y02P 60/216* (2015.11)

(58) **Field of Classification Search**

USPC .. 47/62 R, 59 R, 62 E, 63, 62 C, 83, 82, 79, 47/65, 65.5, 39, 71
See application file for complete search history.

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Primary Examiner — Andrea M Valenti

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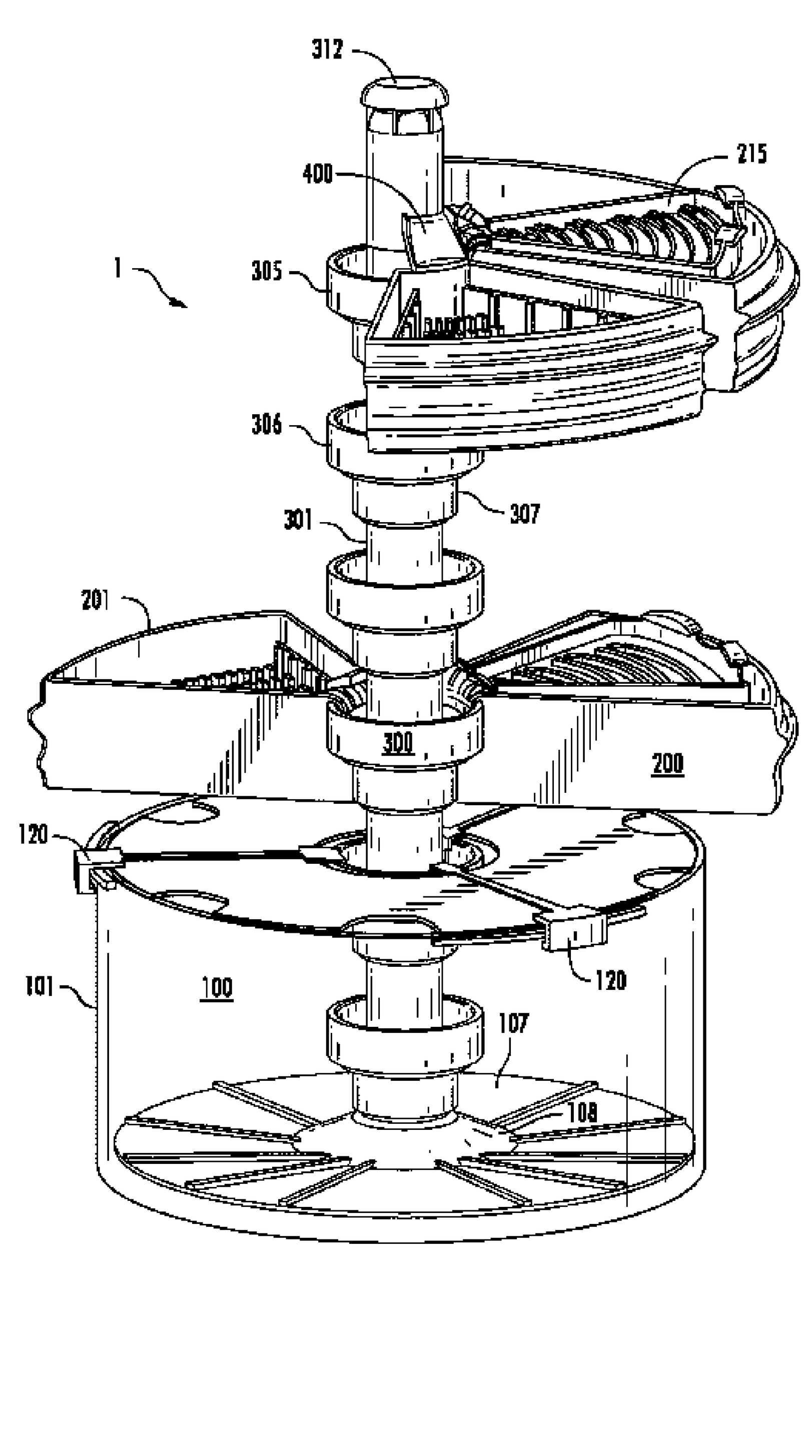
(57) **ABSTRACT**

Embodiments of the invention are directed to aquaponics system. The aquaponics system may be comprised of a pole assembly comprising a pole having one or more pole cups affixed to the pole in a vertical orientation; an aquaculture assembly comprising a tank having a pole anchor centered therein, wherein the pole anchor is configured to receive a bottom portion of the pole, a plurality of struts configured to stabilize the pole within the tank, and at least one tank cover positioned at an opening of the tank; and a hydroponic assembly comprising one or more grow pans, wherein the one or more grow pans are removably coupled with the pole assembly, and at least one tray positioned within at least one grow pan.

20 Claims, 34 Drawing Sheets



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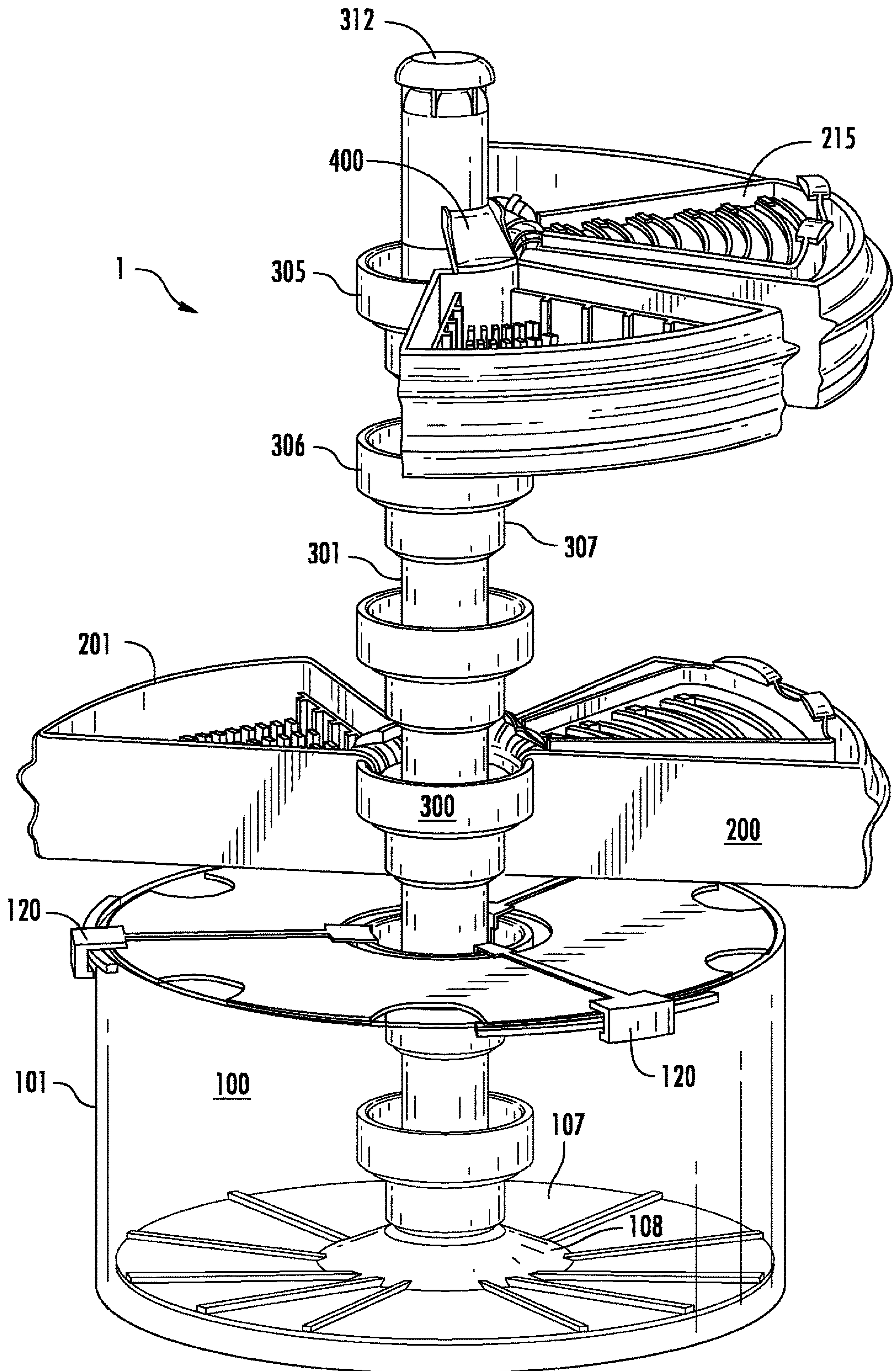
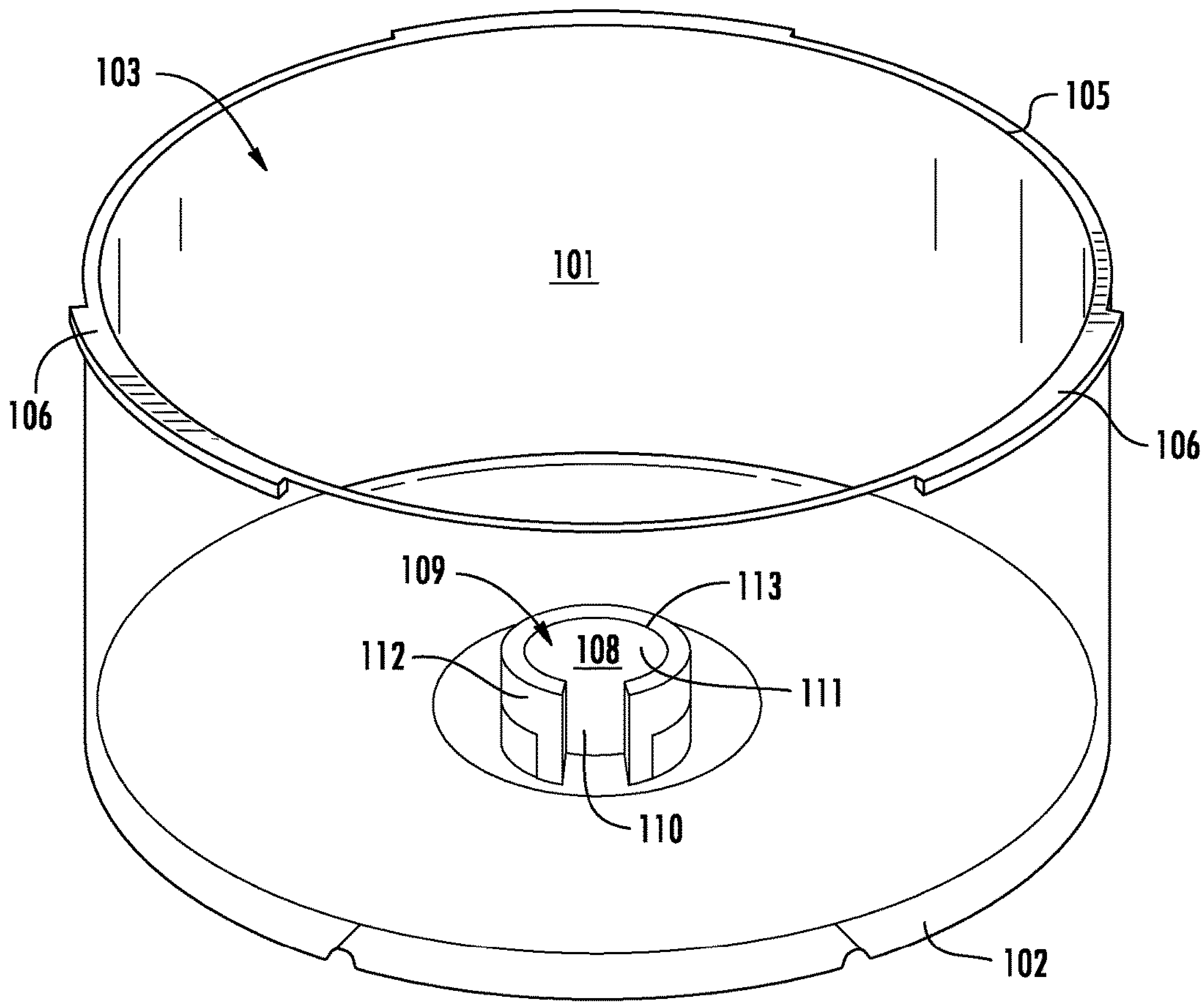


FIG. 1



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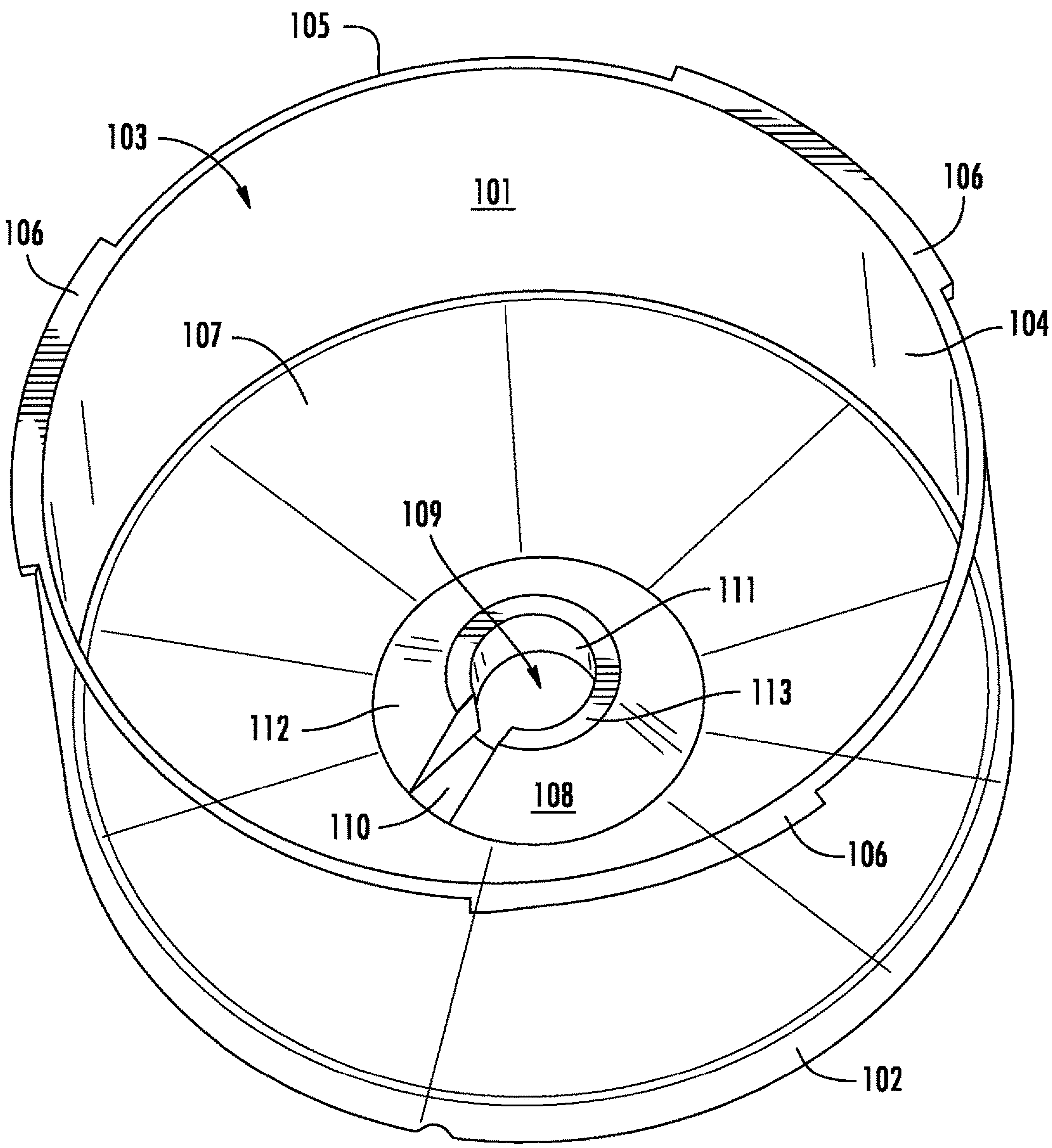

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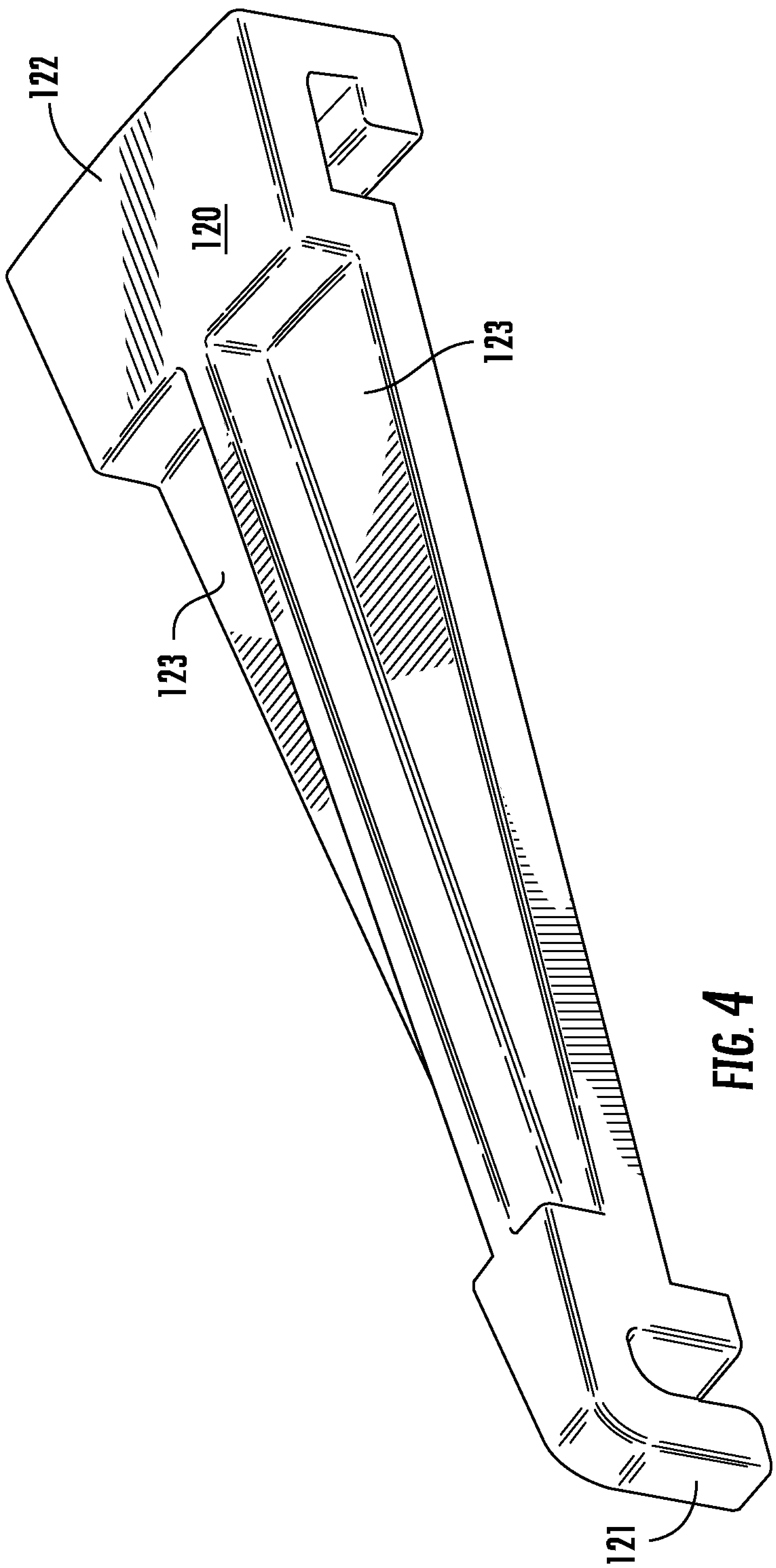

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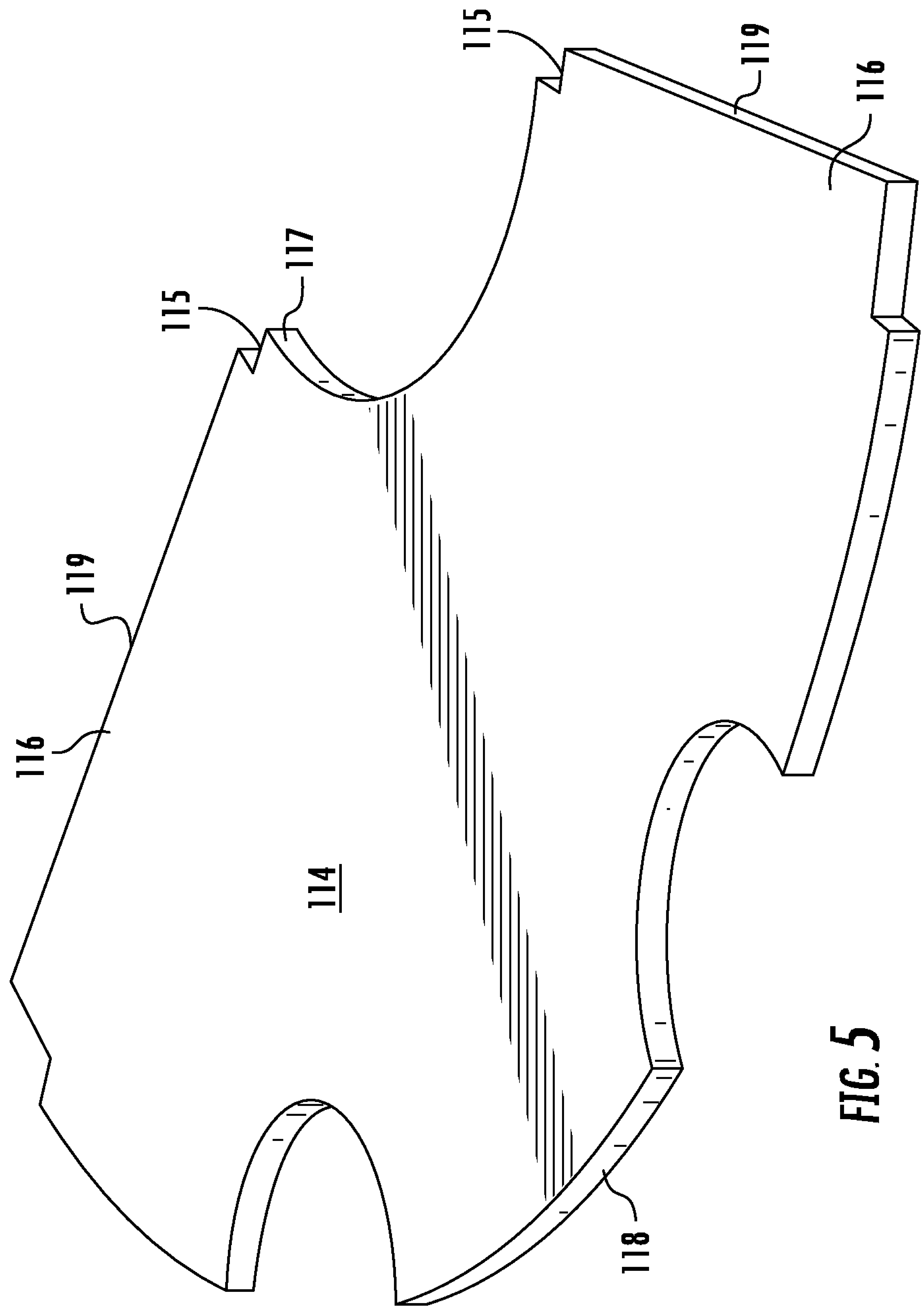

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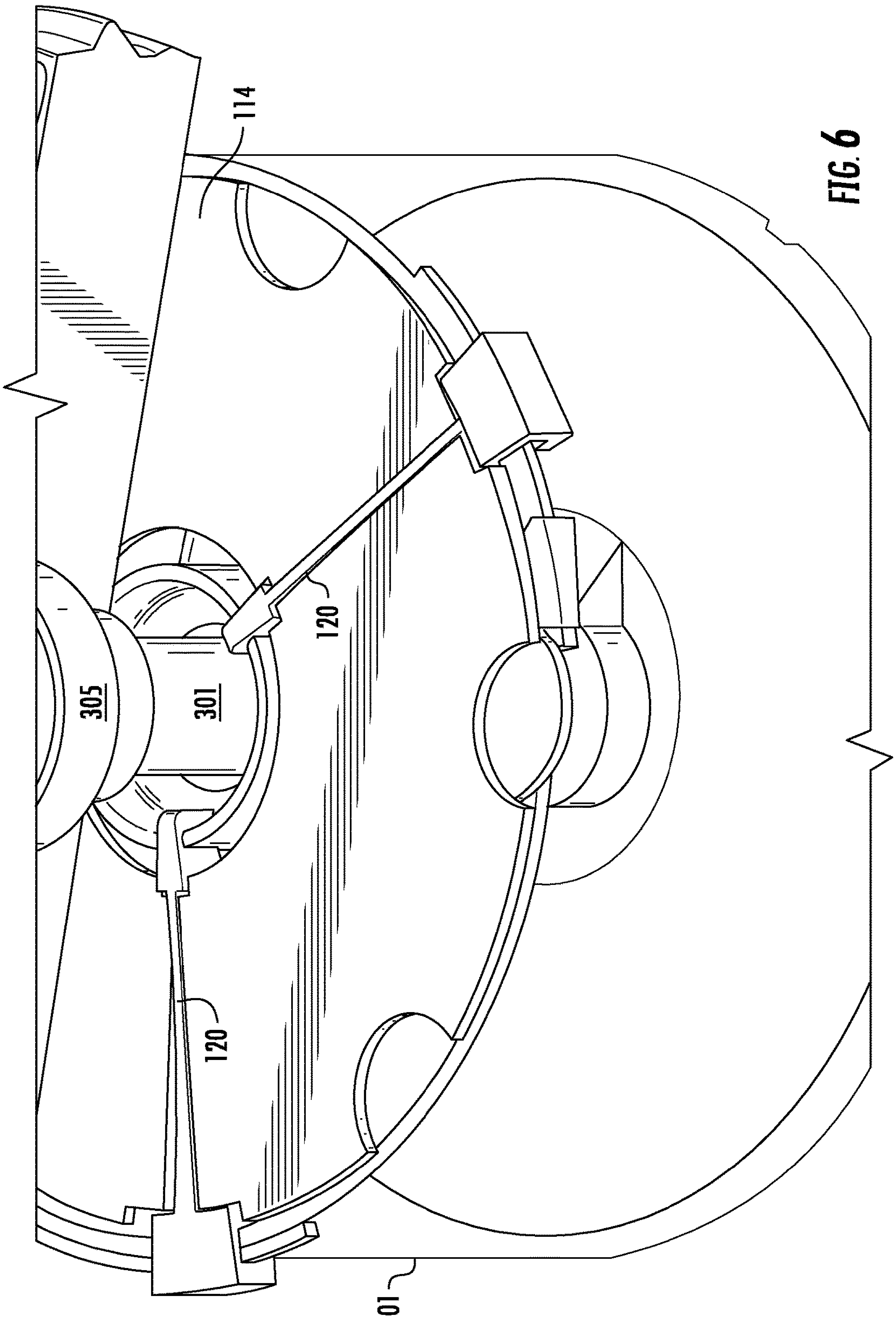

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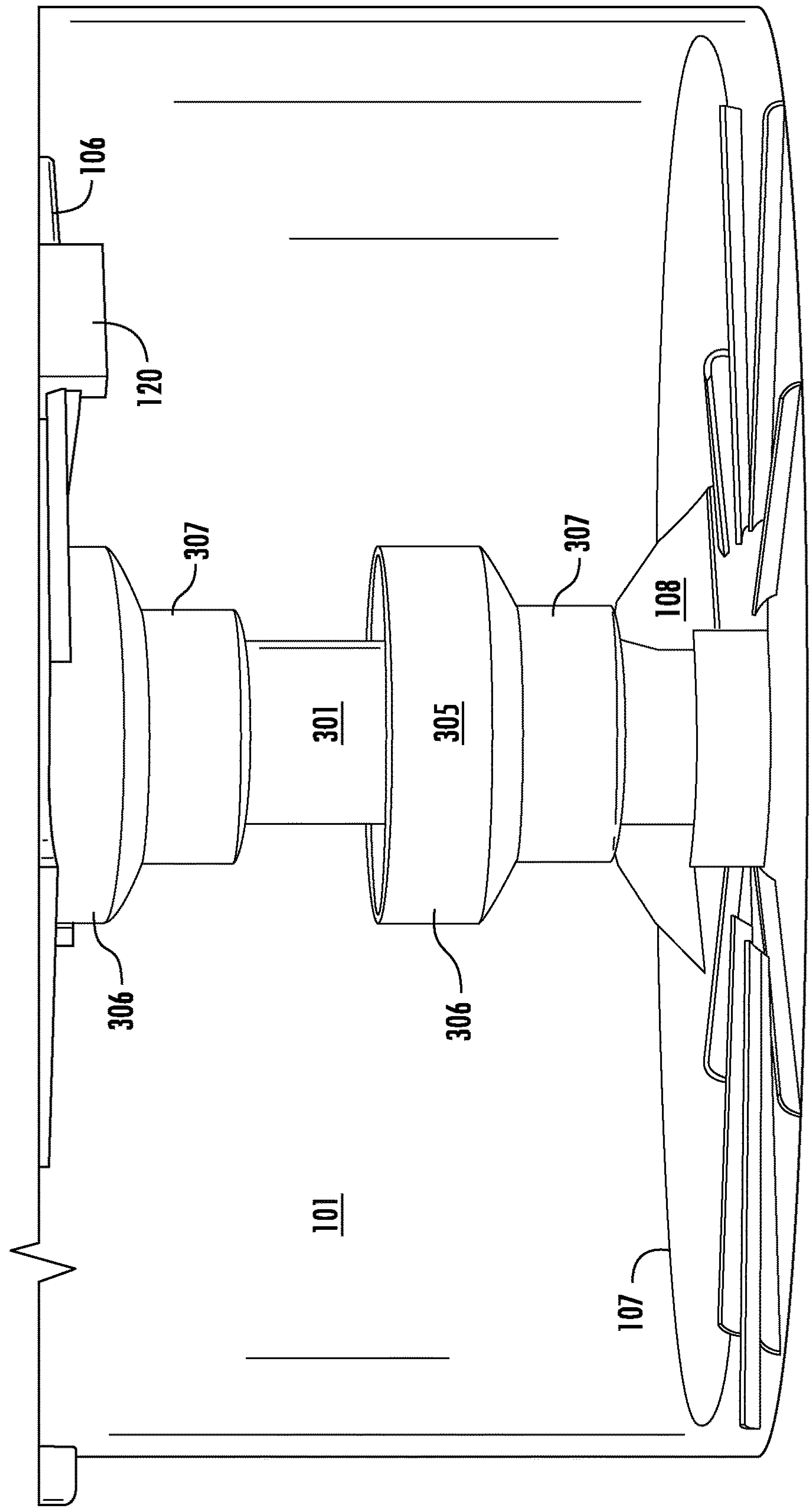

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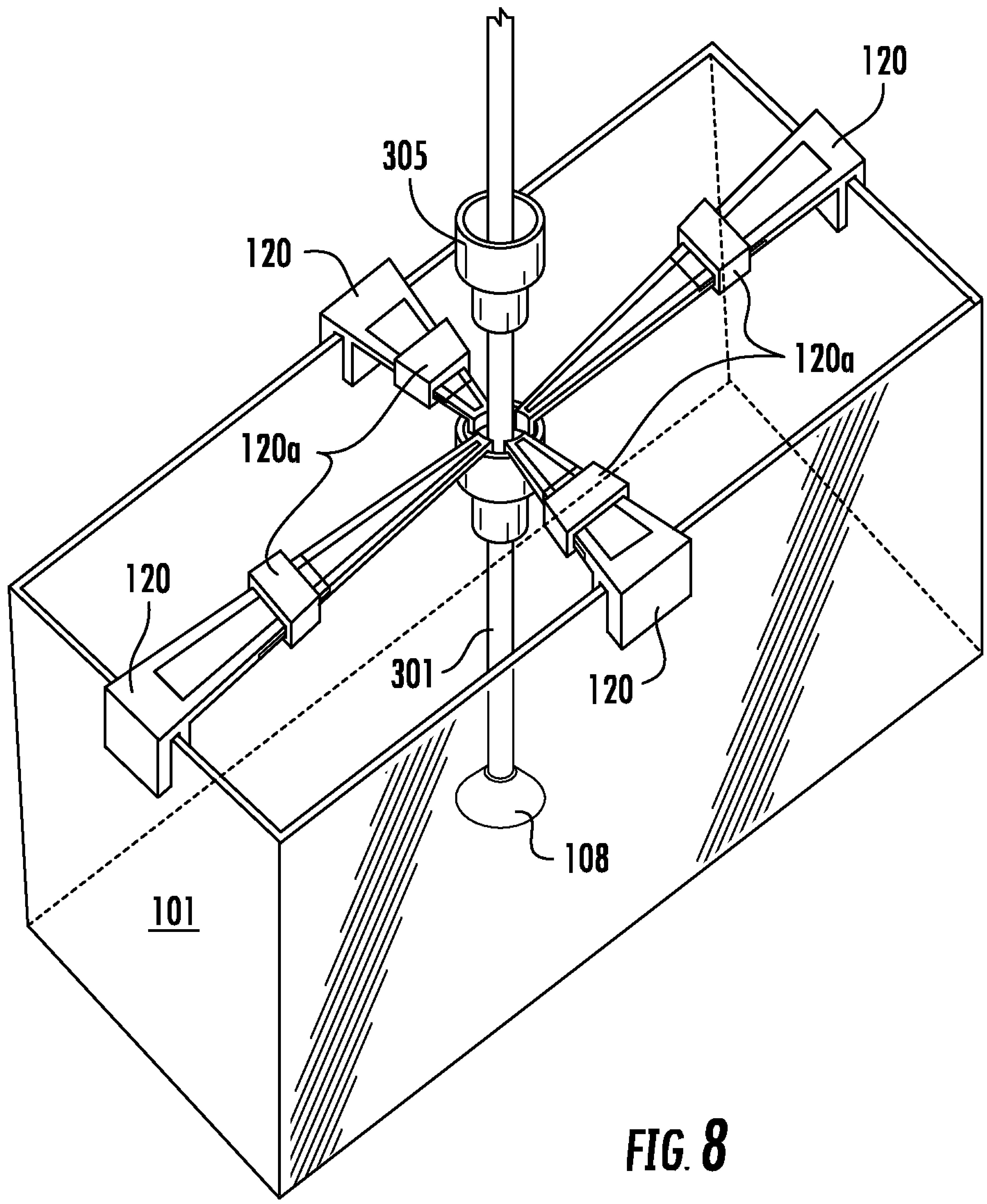

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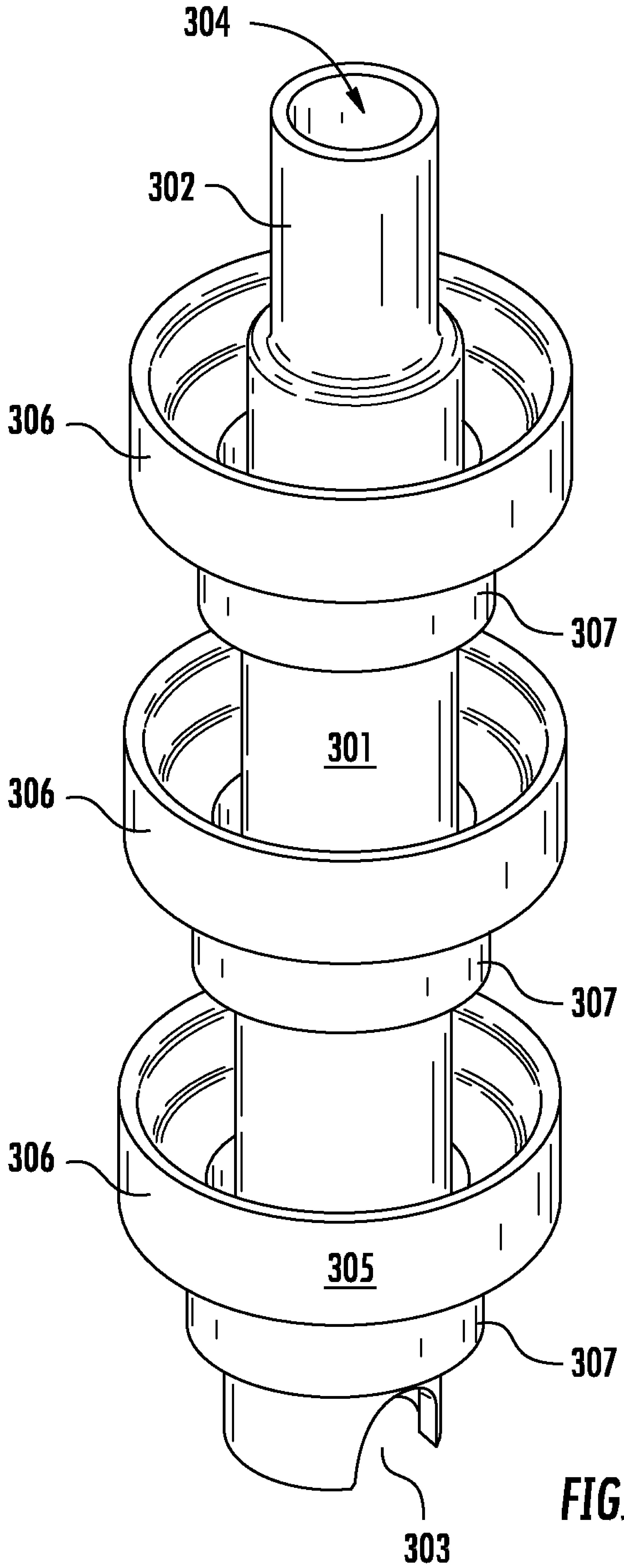

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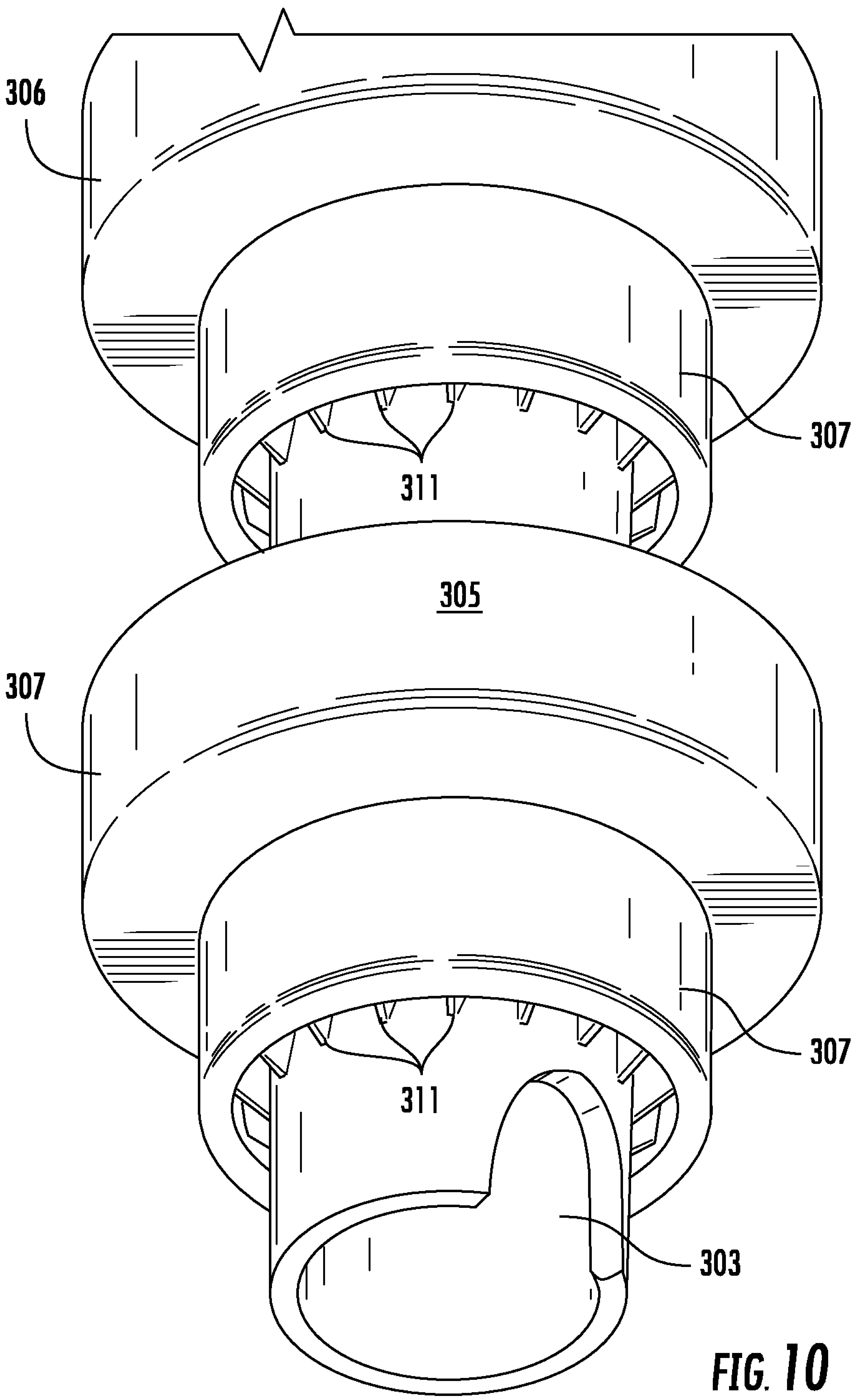

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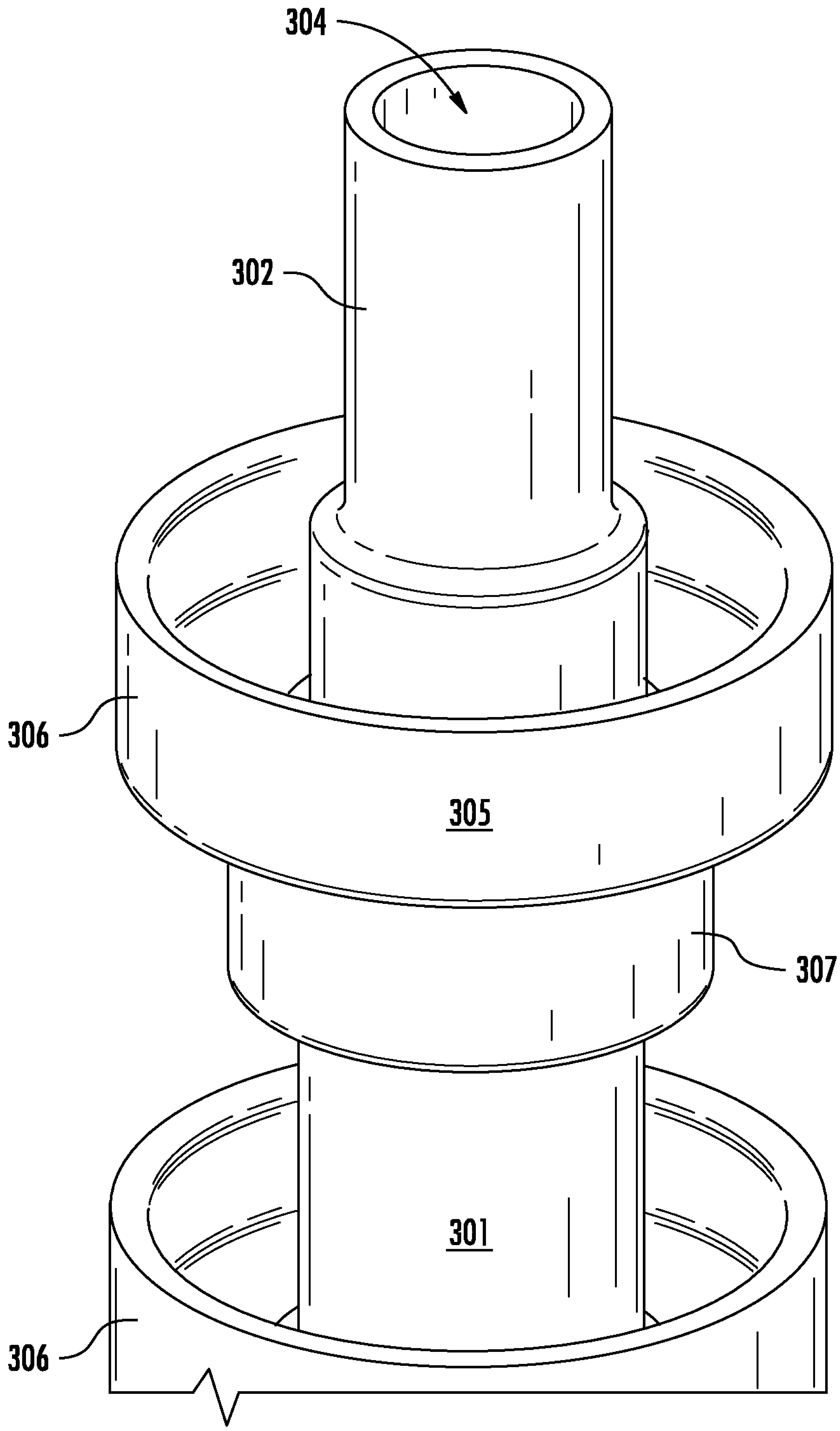

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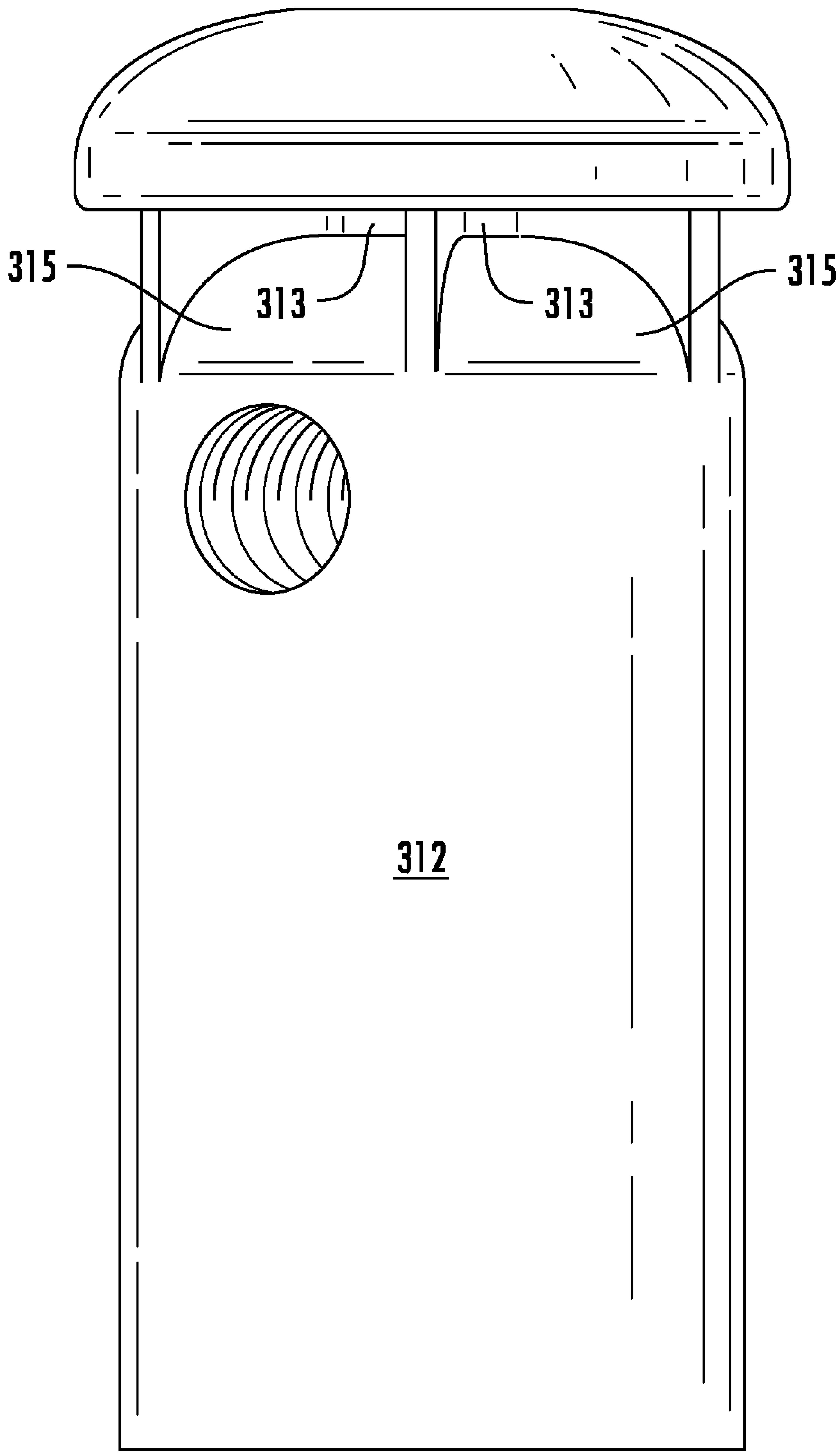

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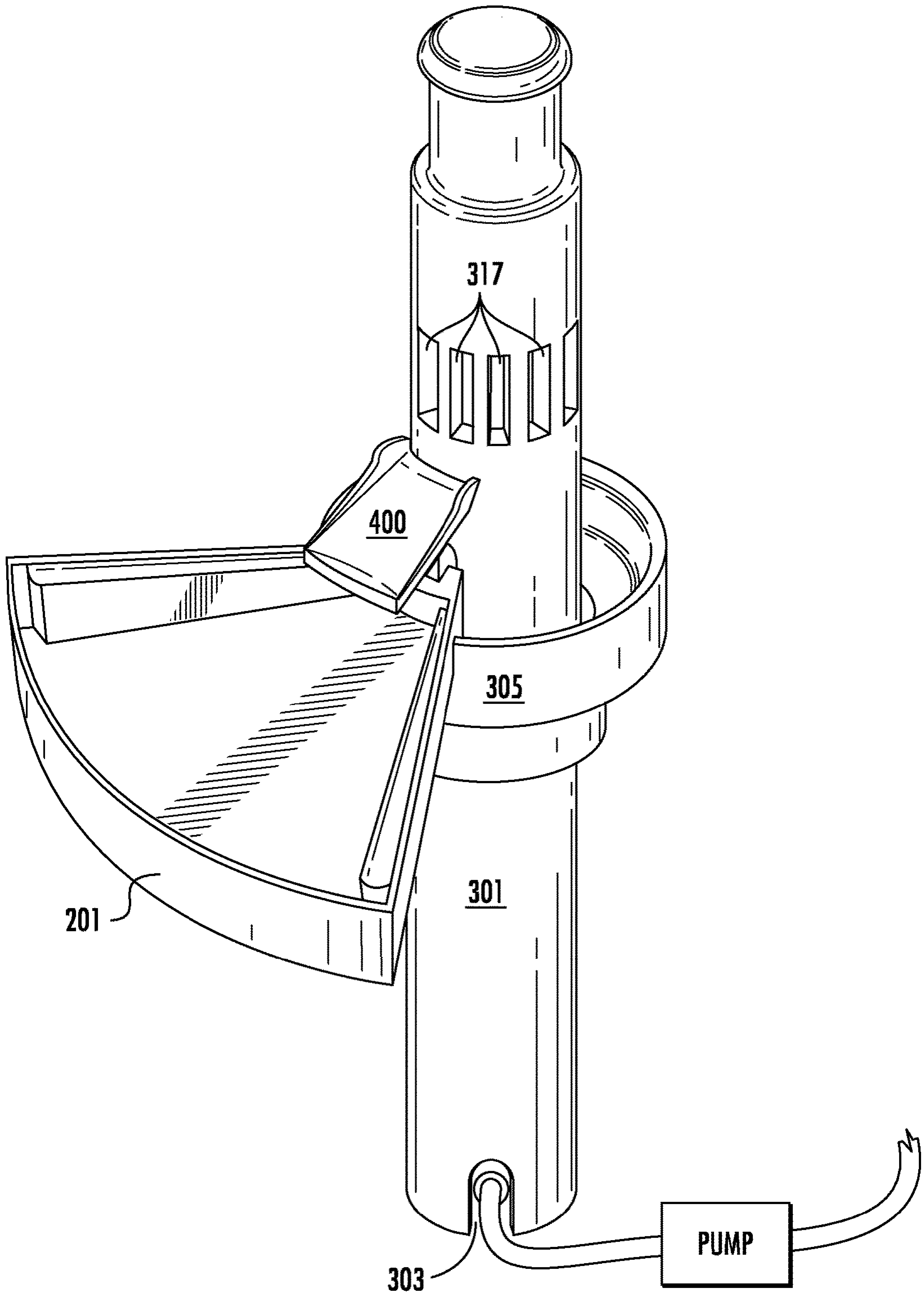


FIG. 13A

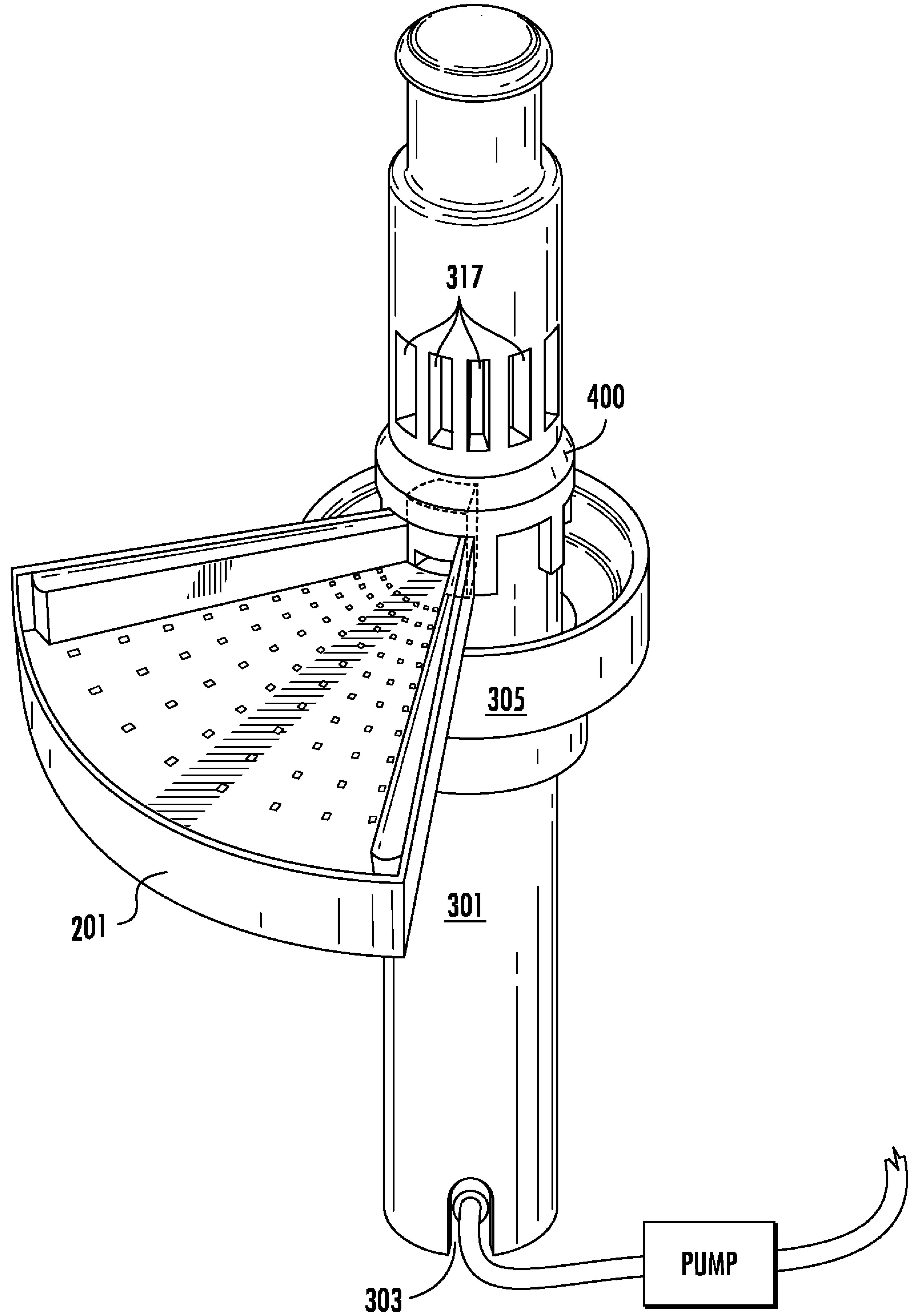
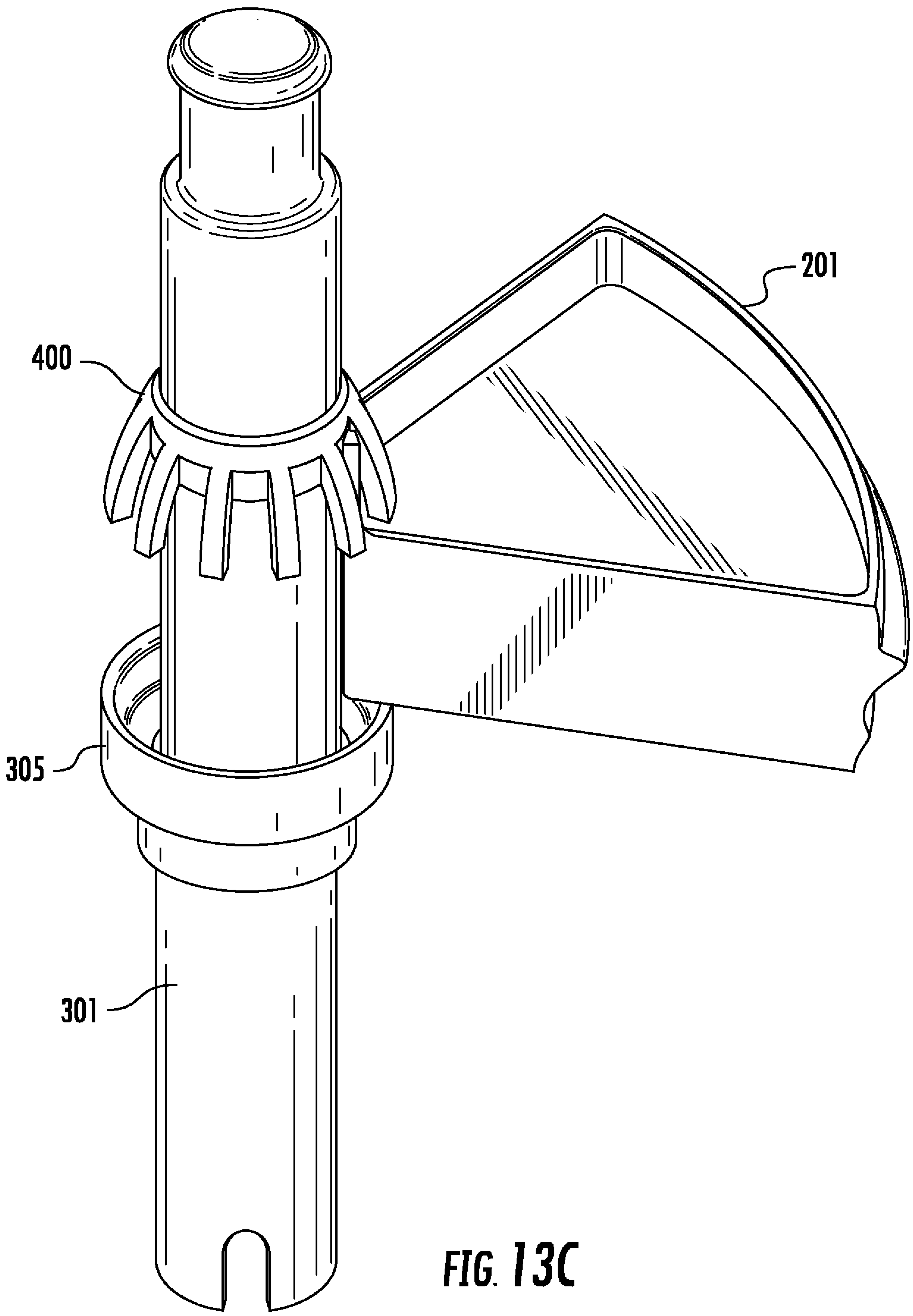


FIG. 13B



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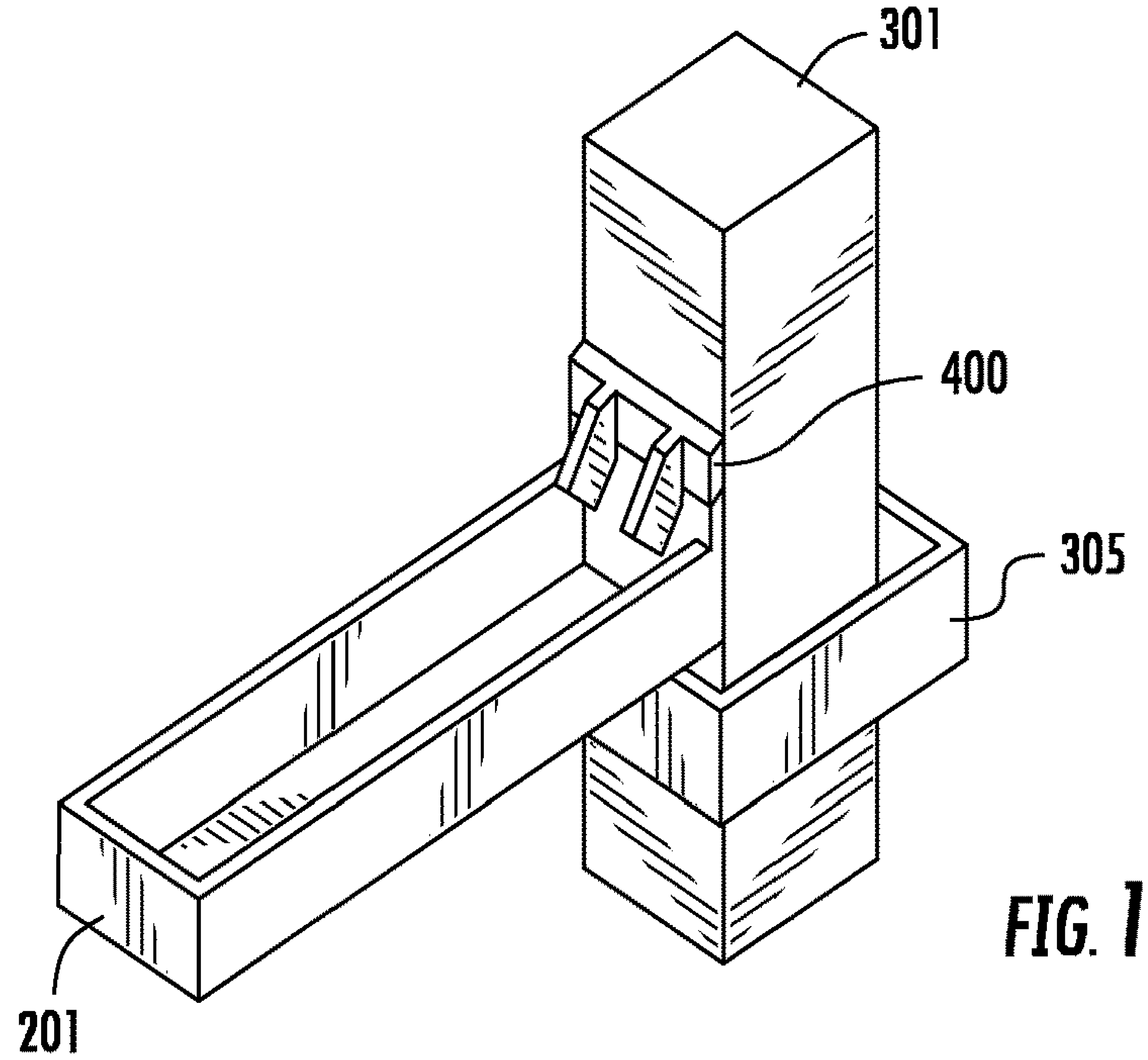

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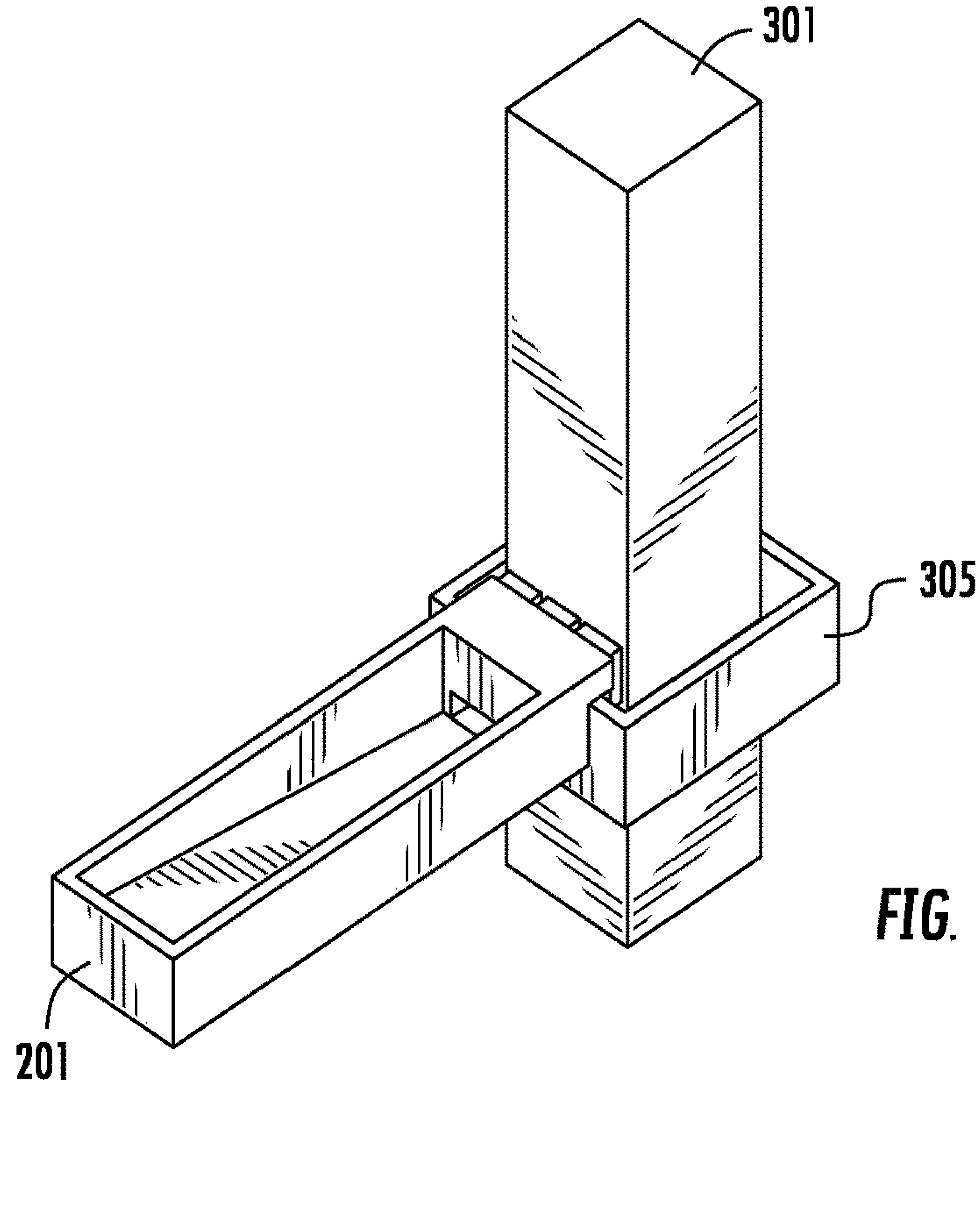

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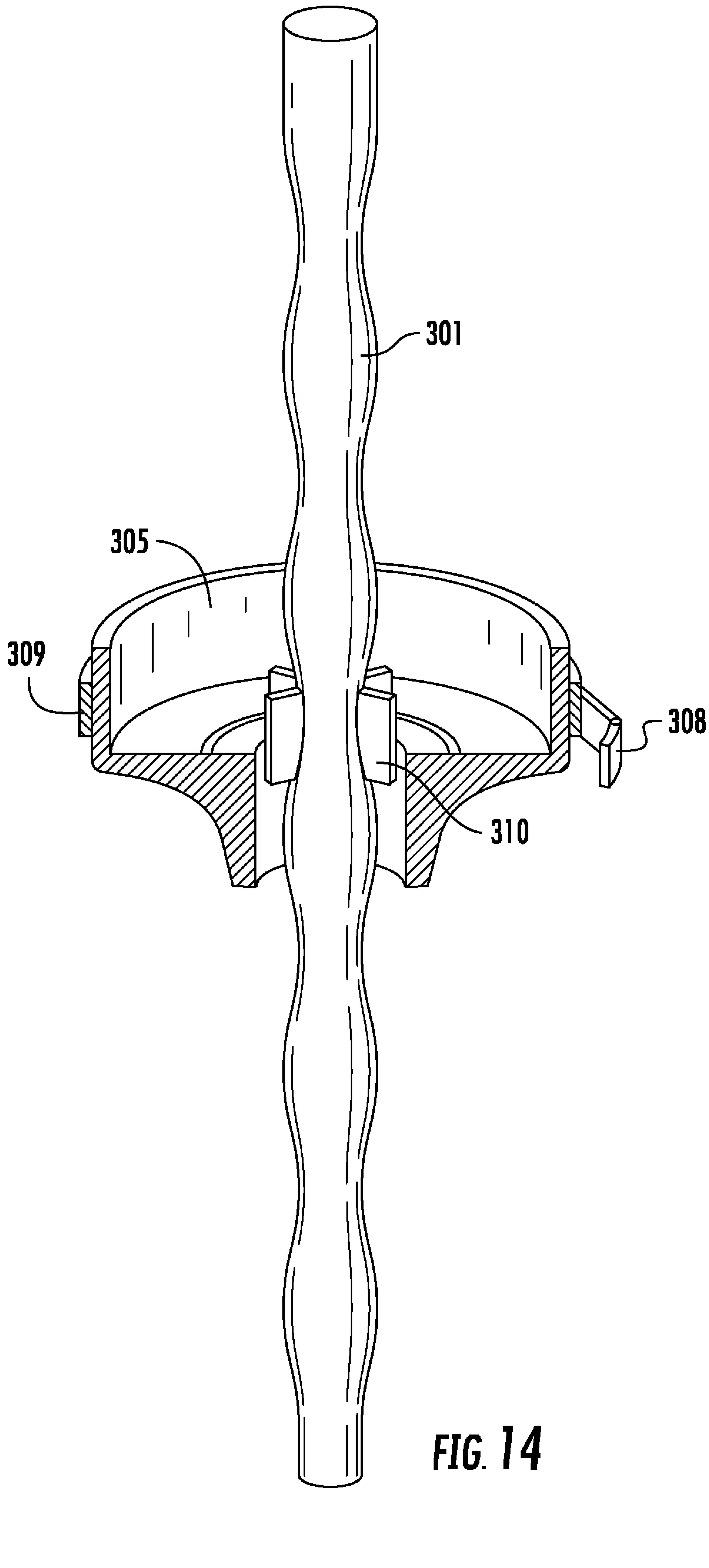

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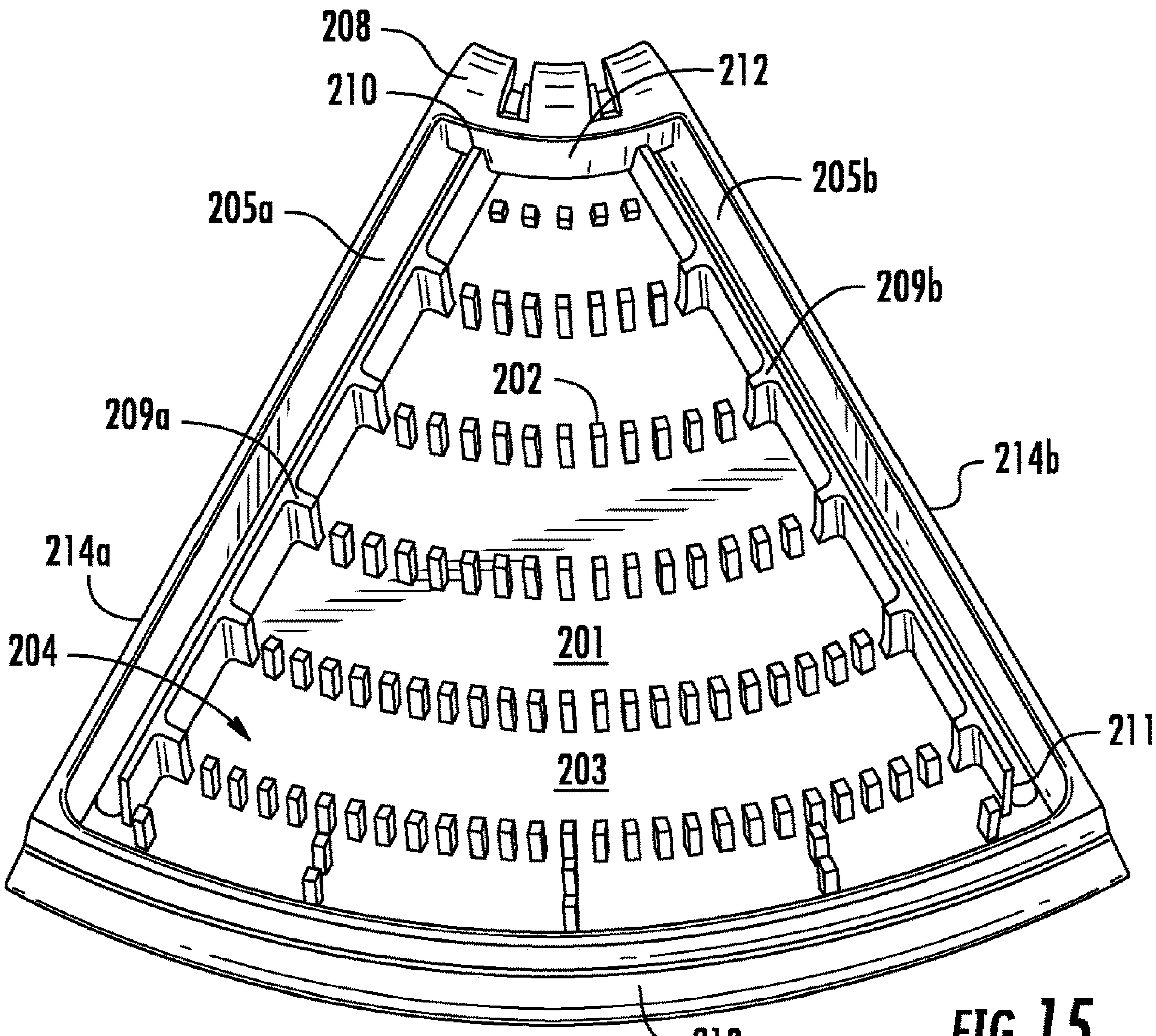
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212
205a
205b
209b
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209a
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214a
201
204
203
211
213

FIG. 15

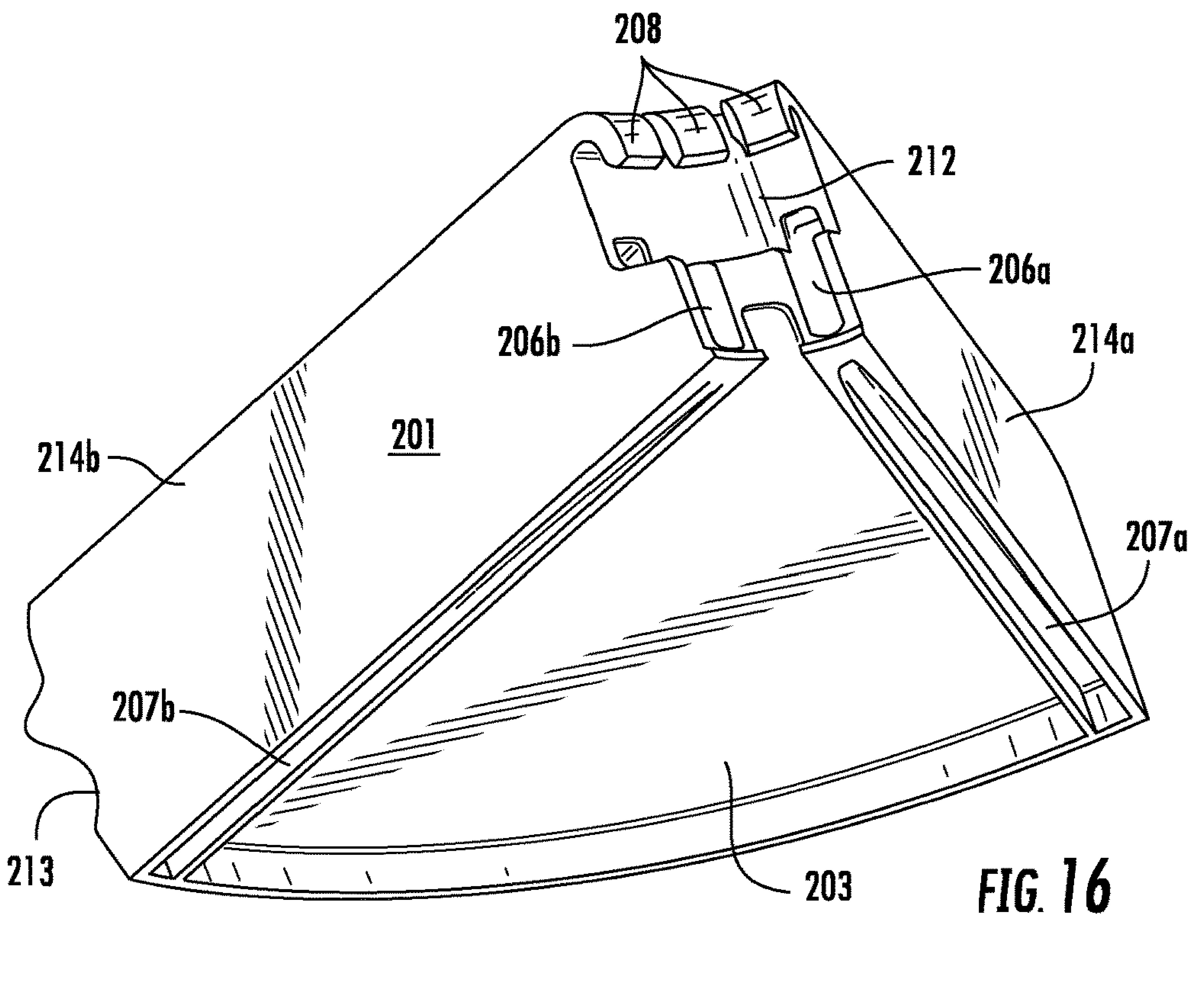
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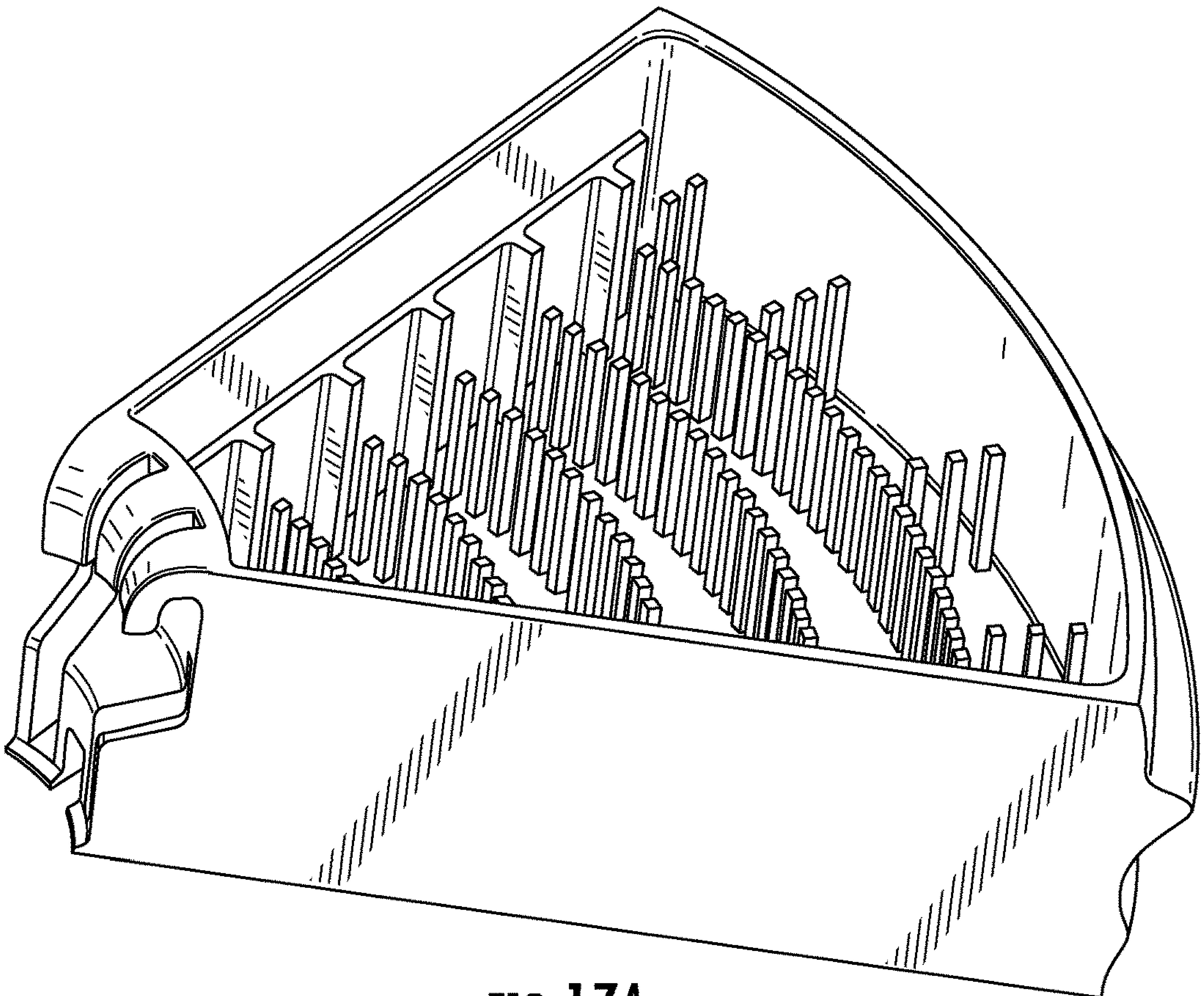
FIG. 16



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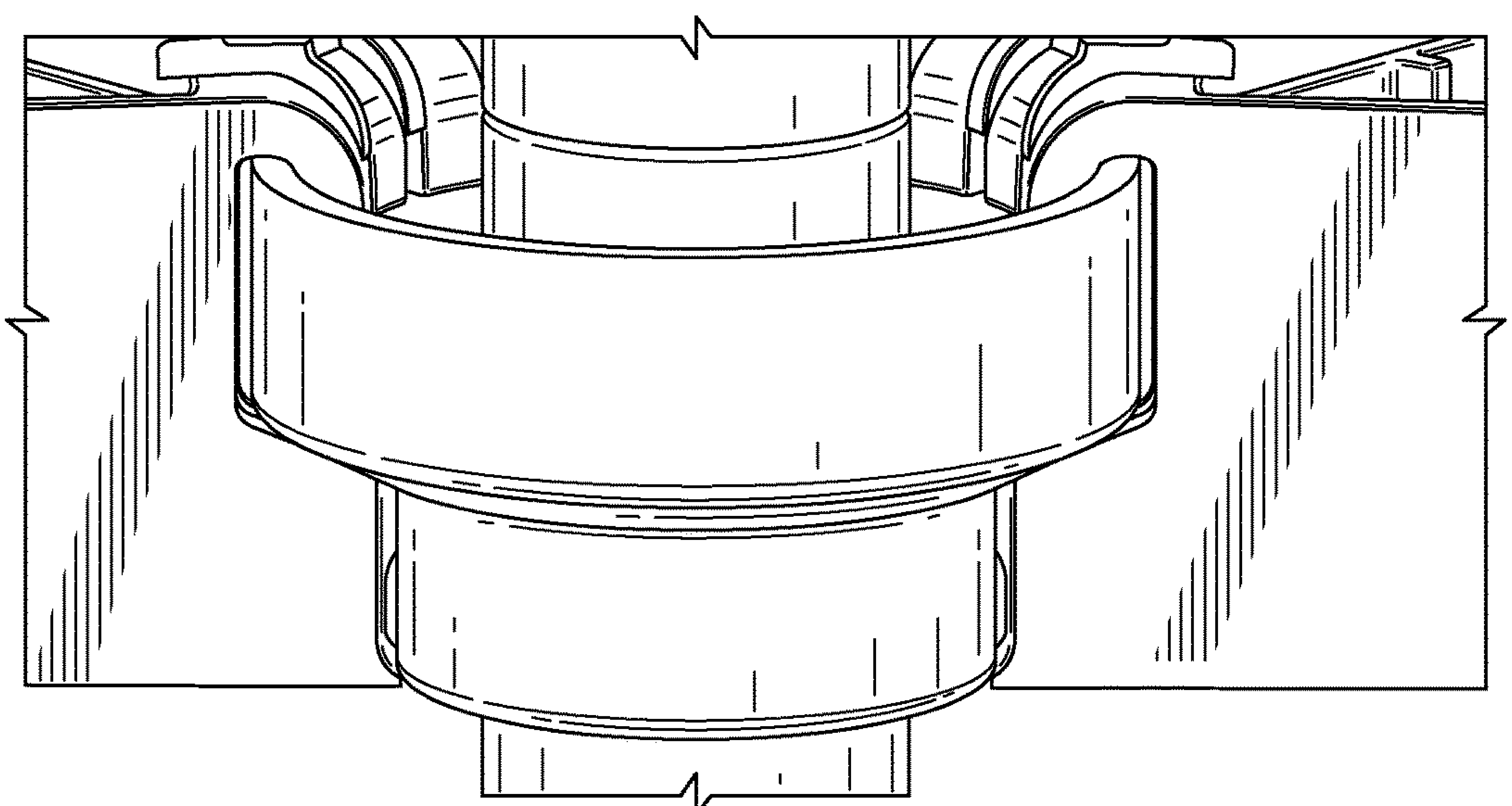

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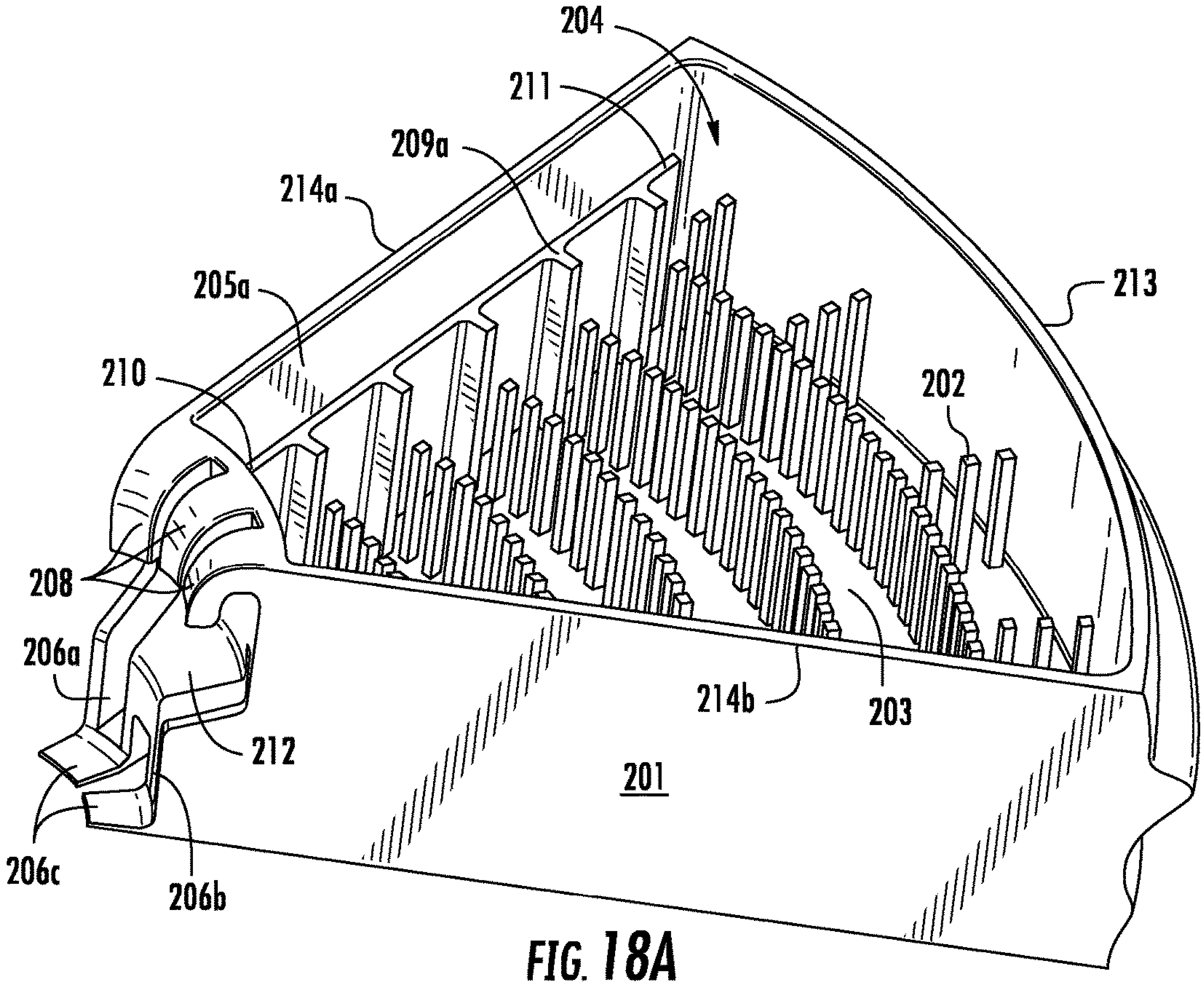

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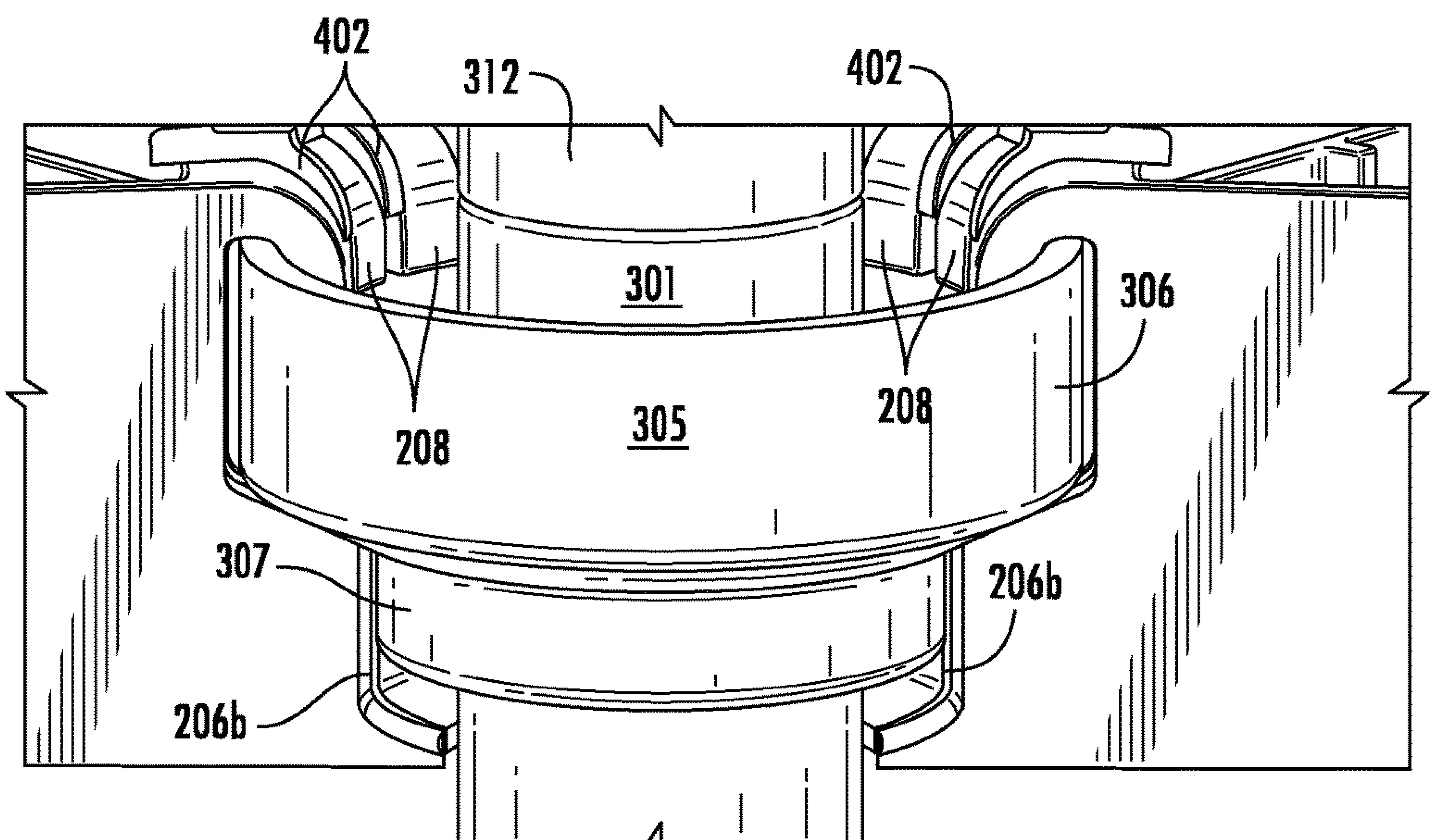

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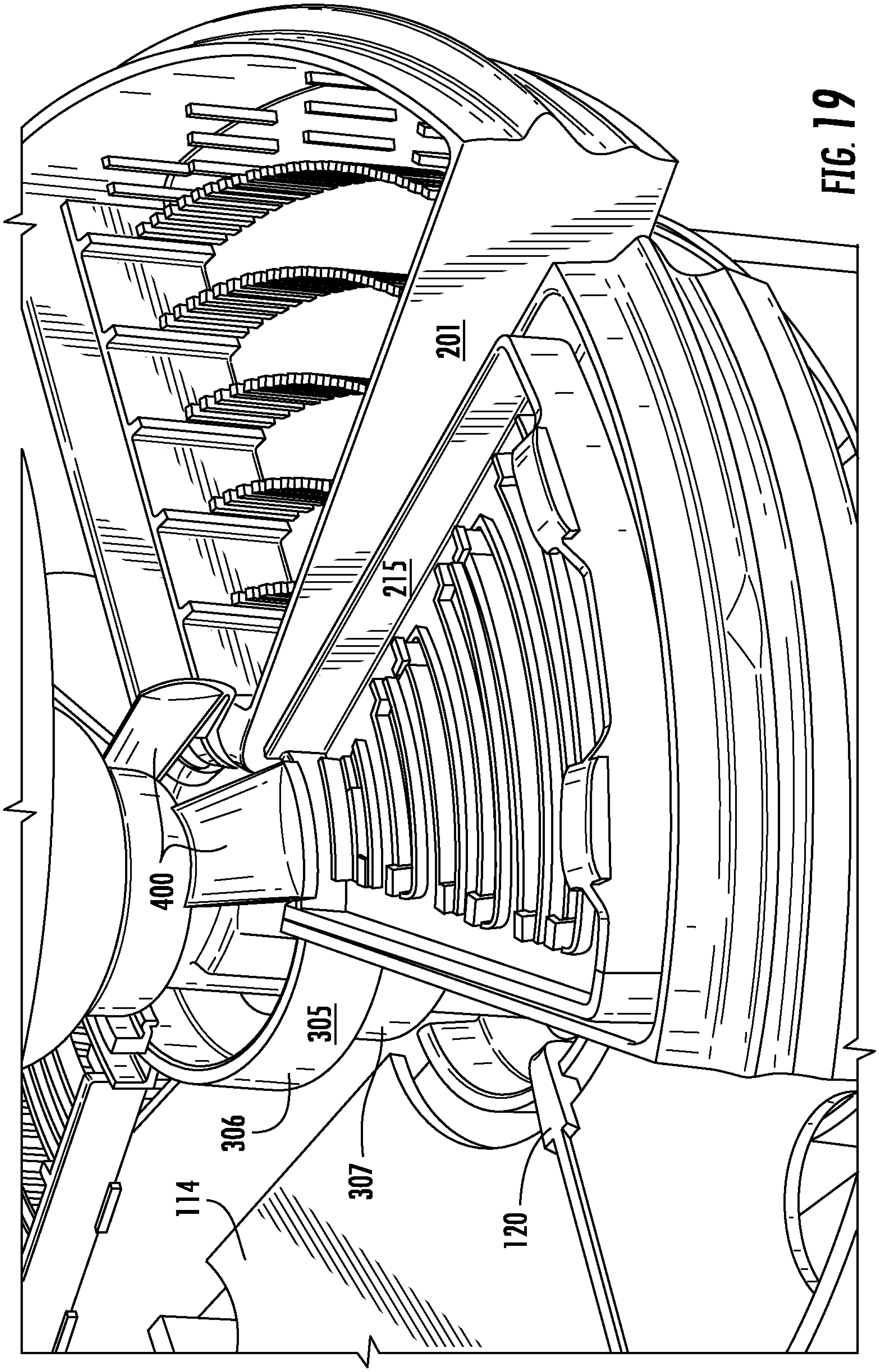

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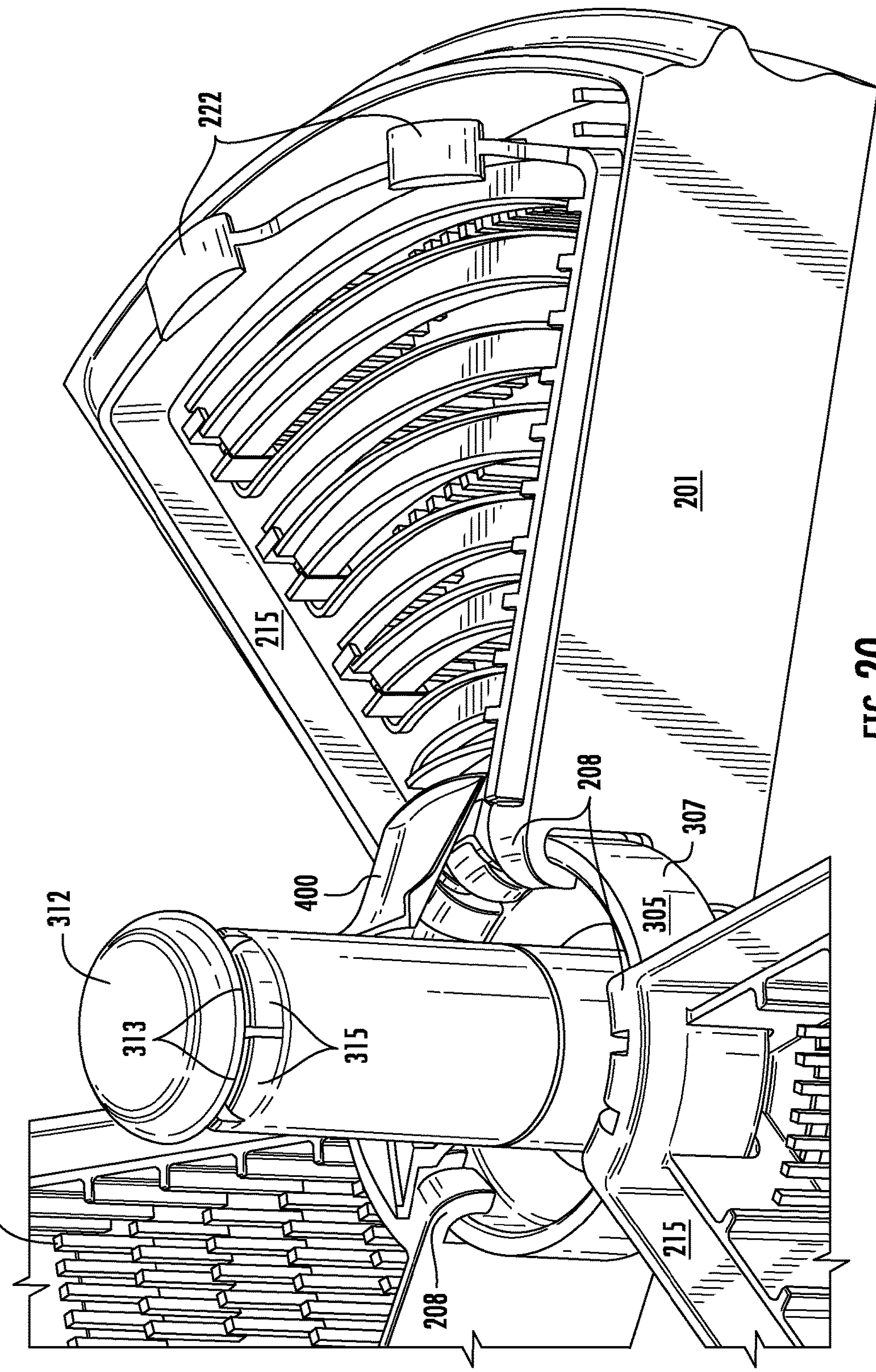

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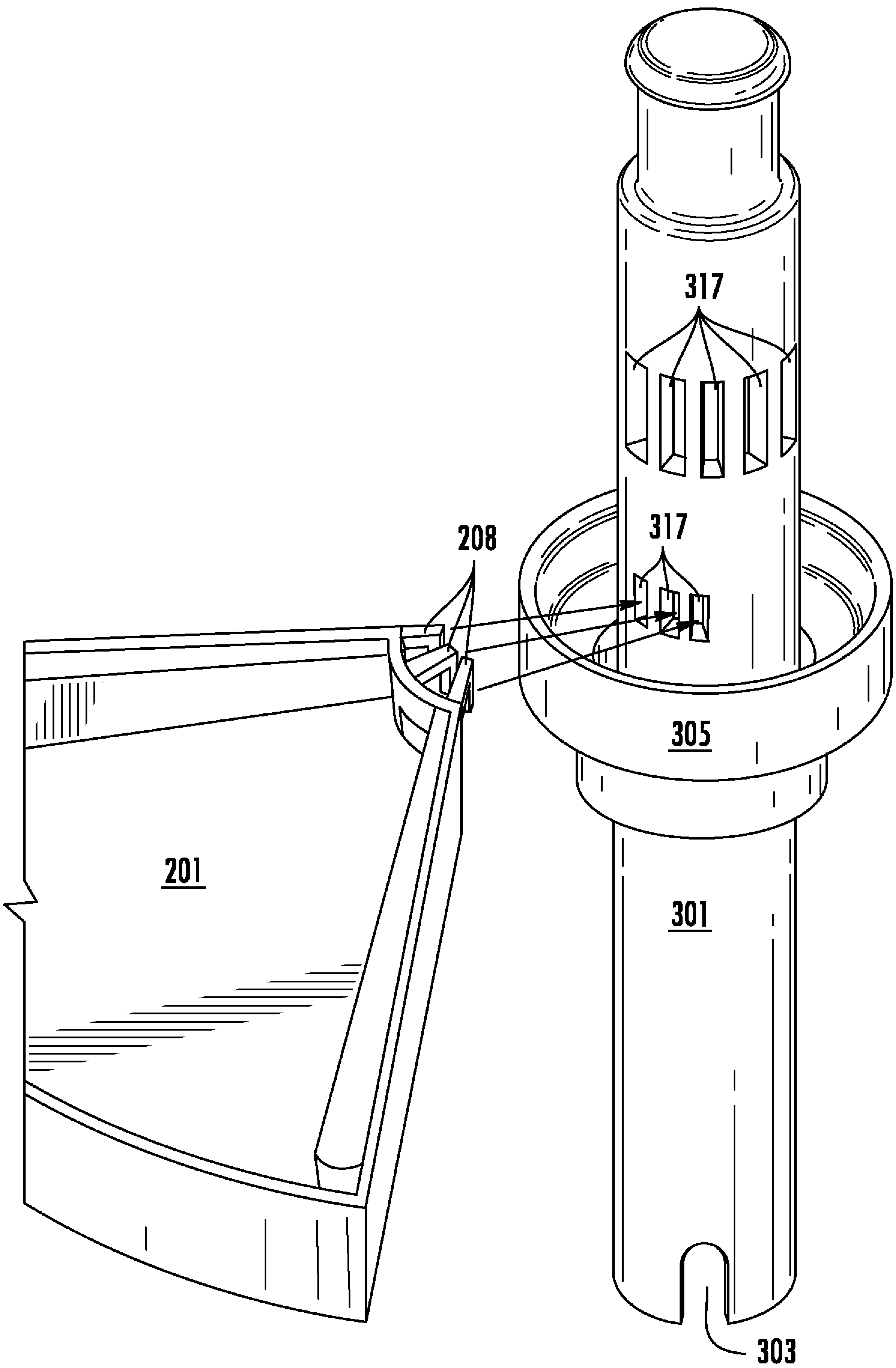

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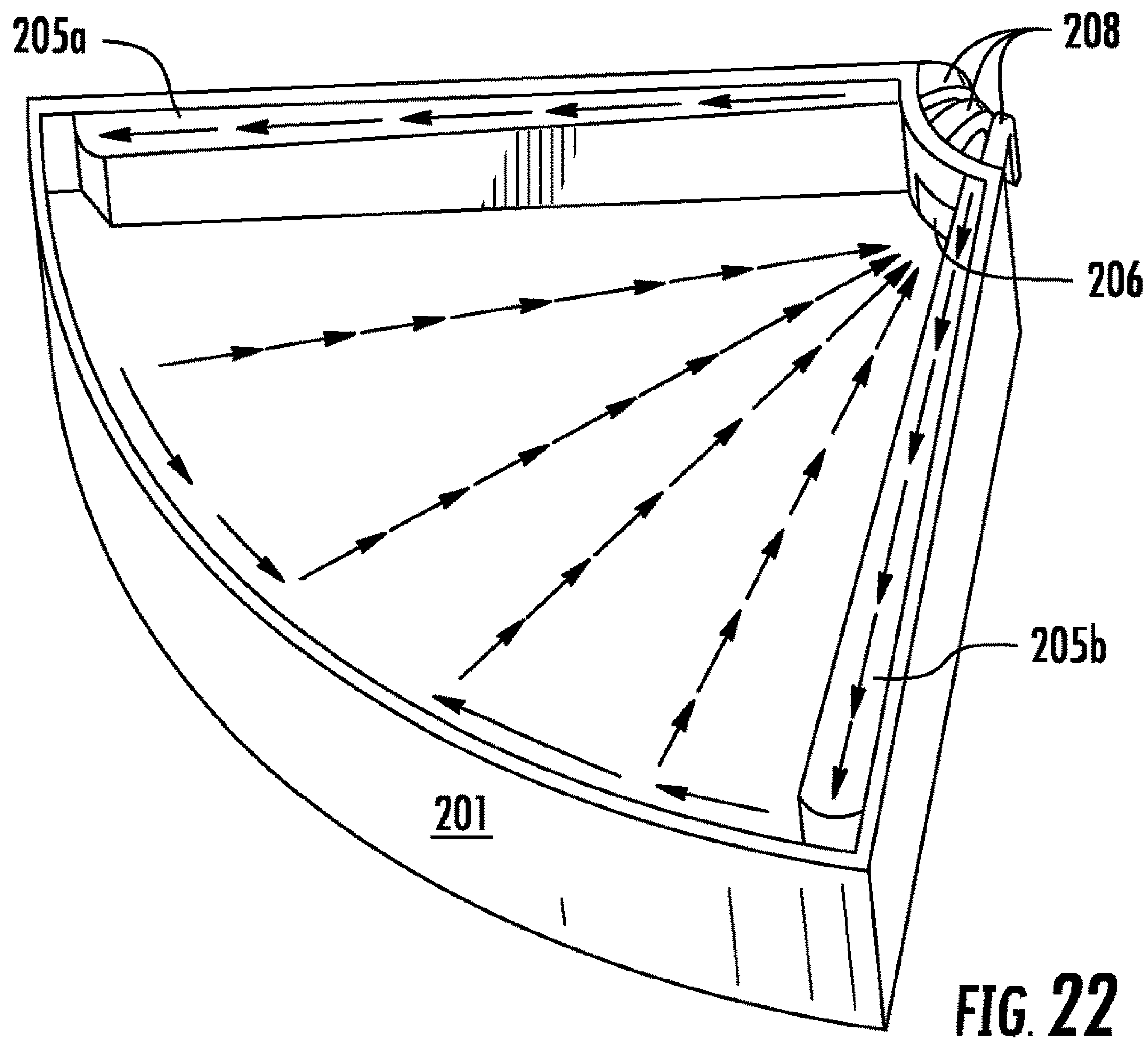
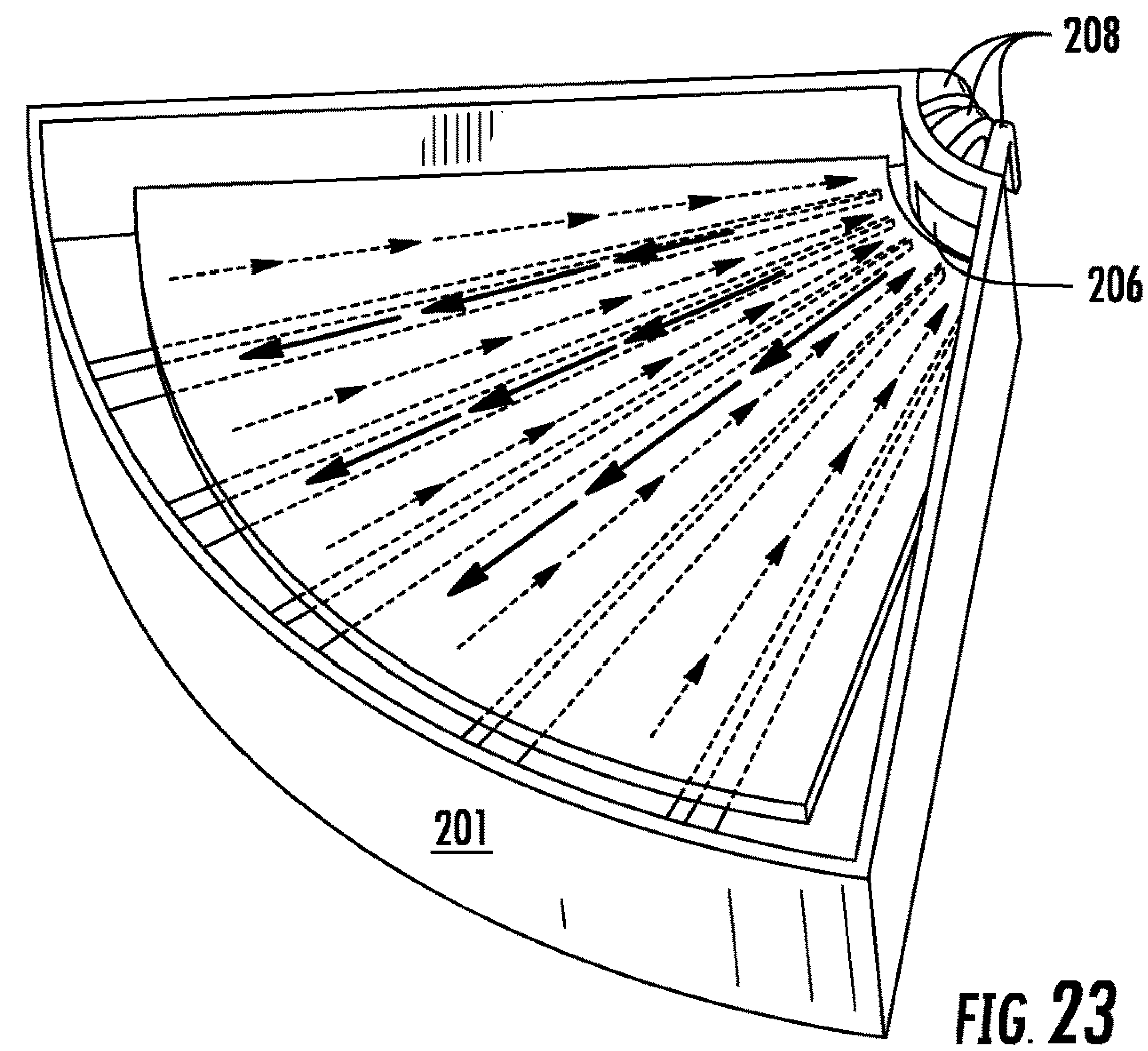


FIG. 22



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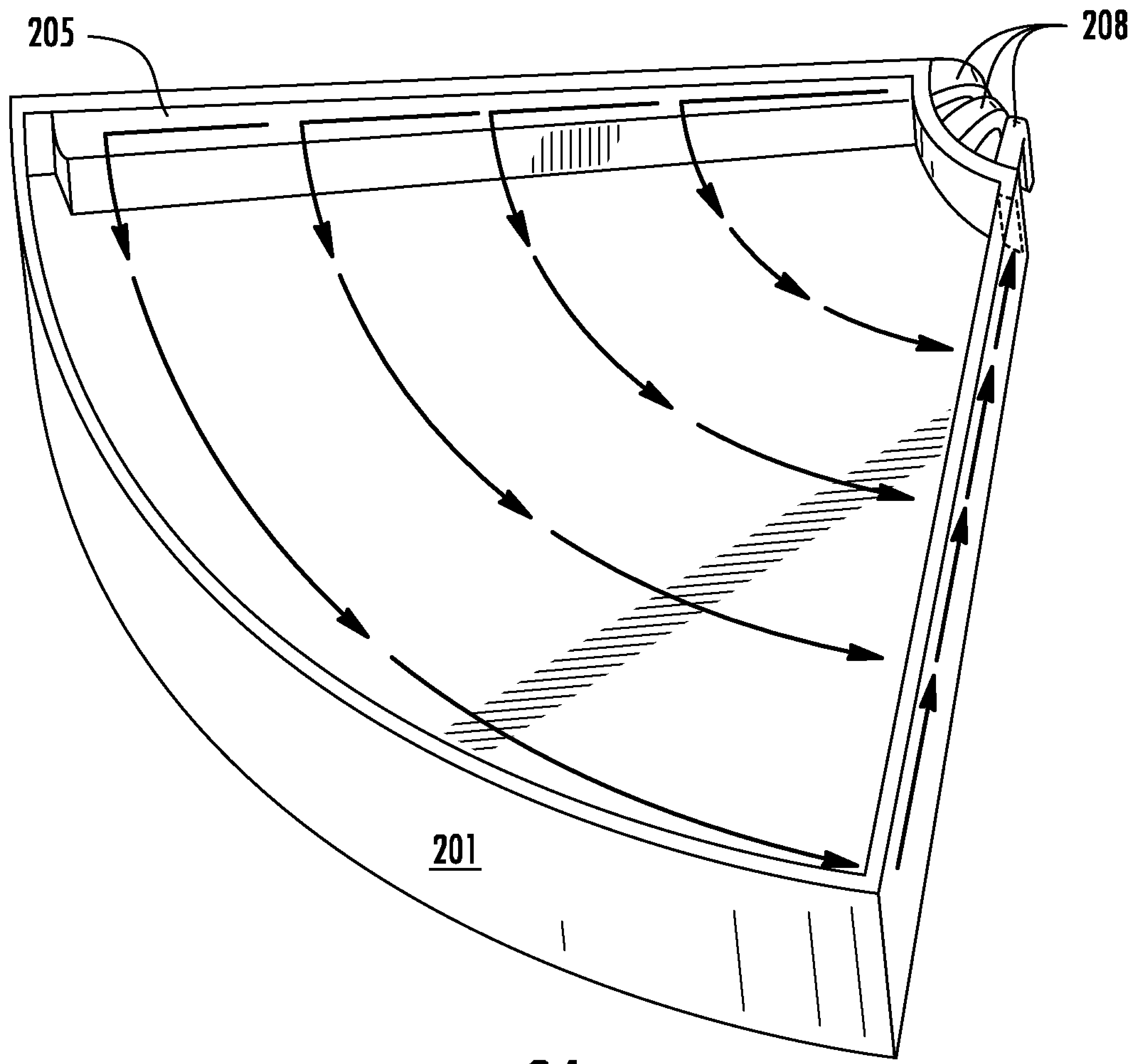

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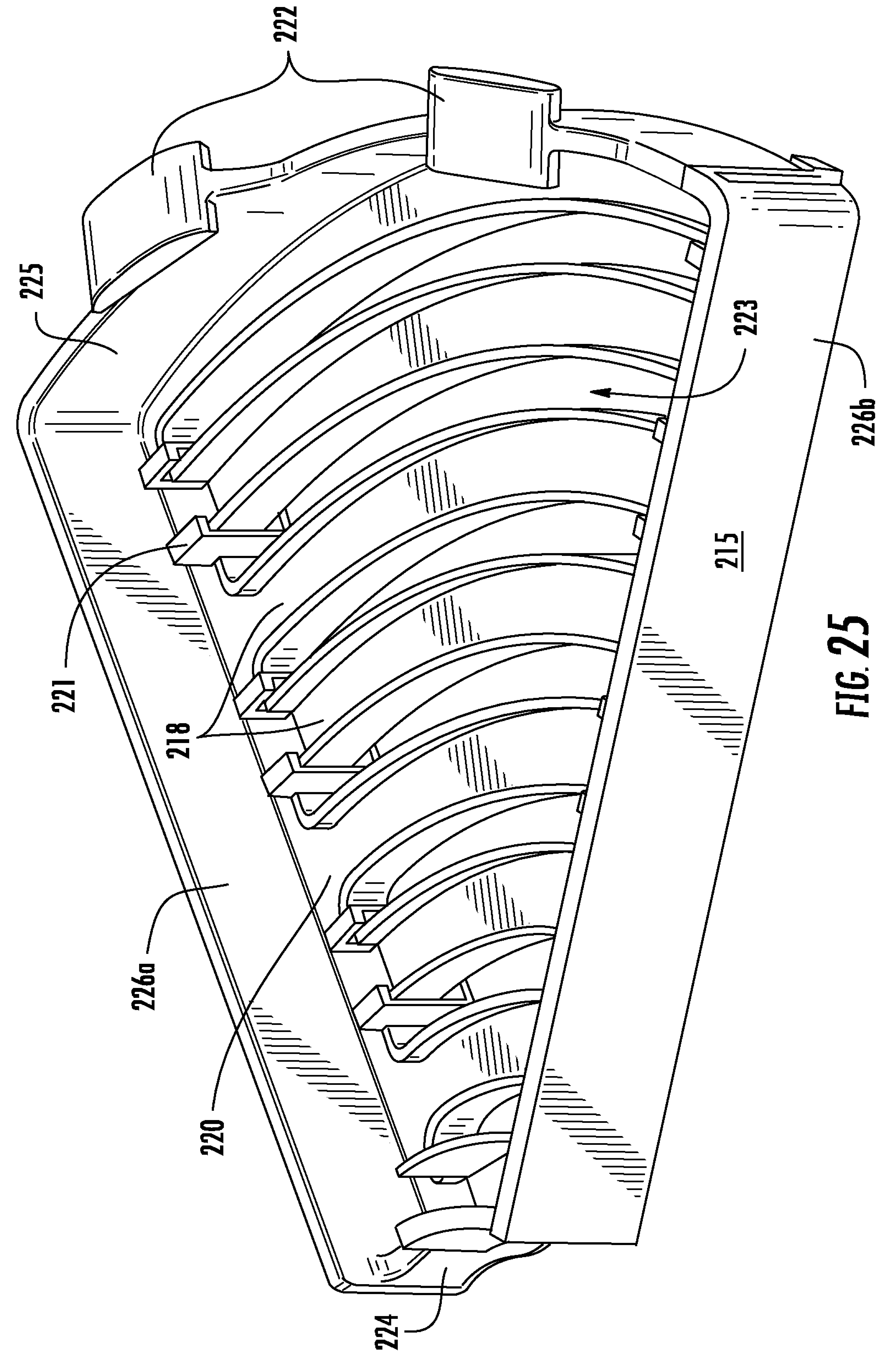

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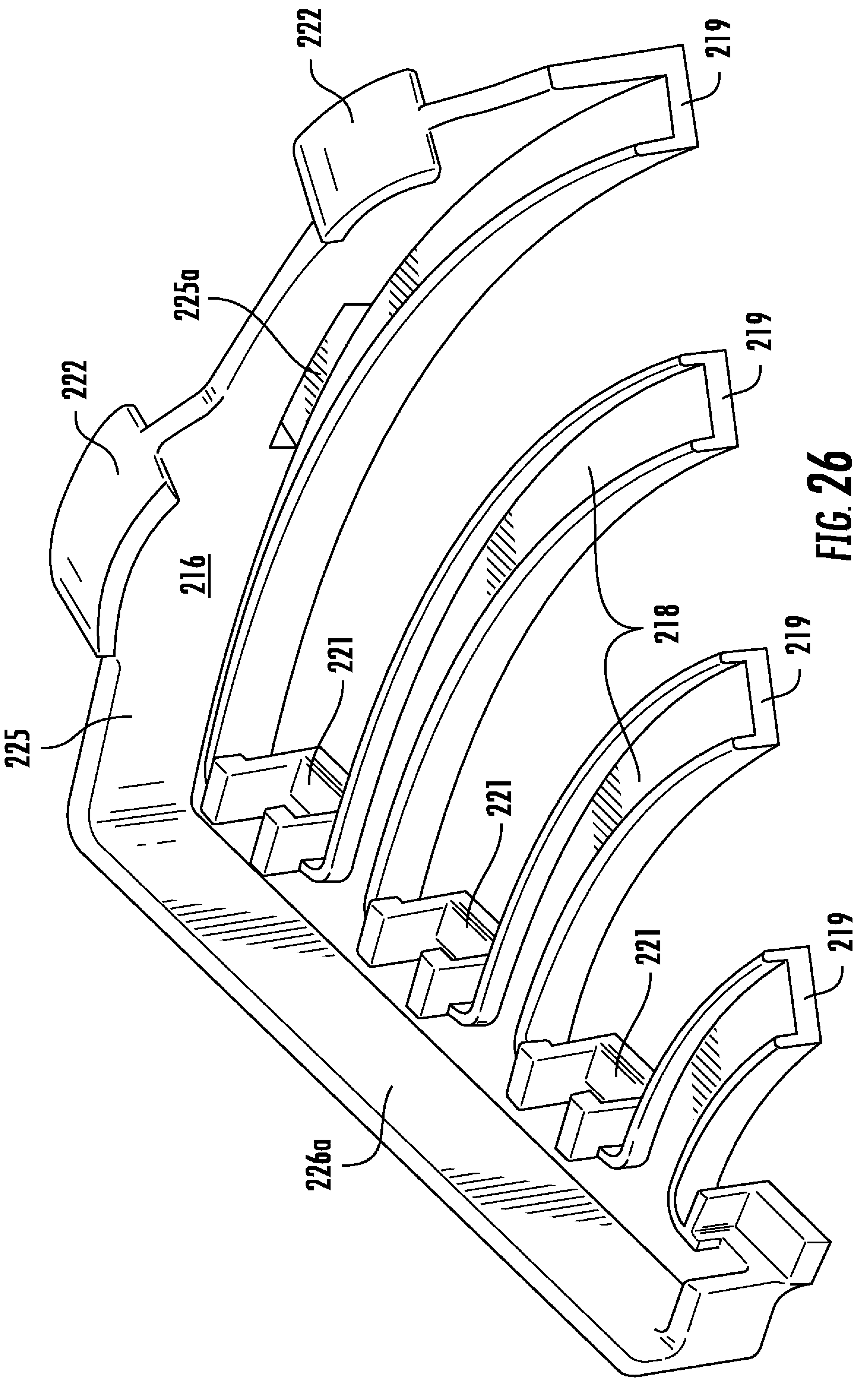


FIG. 26

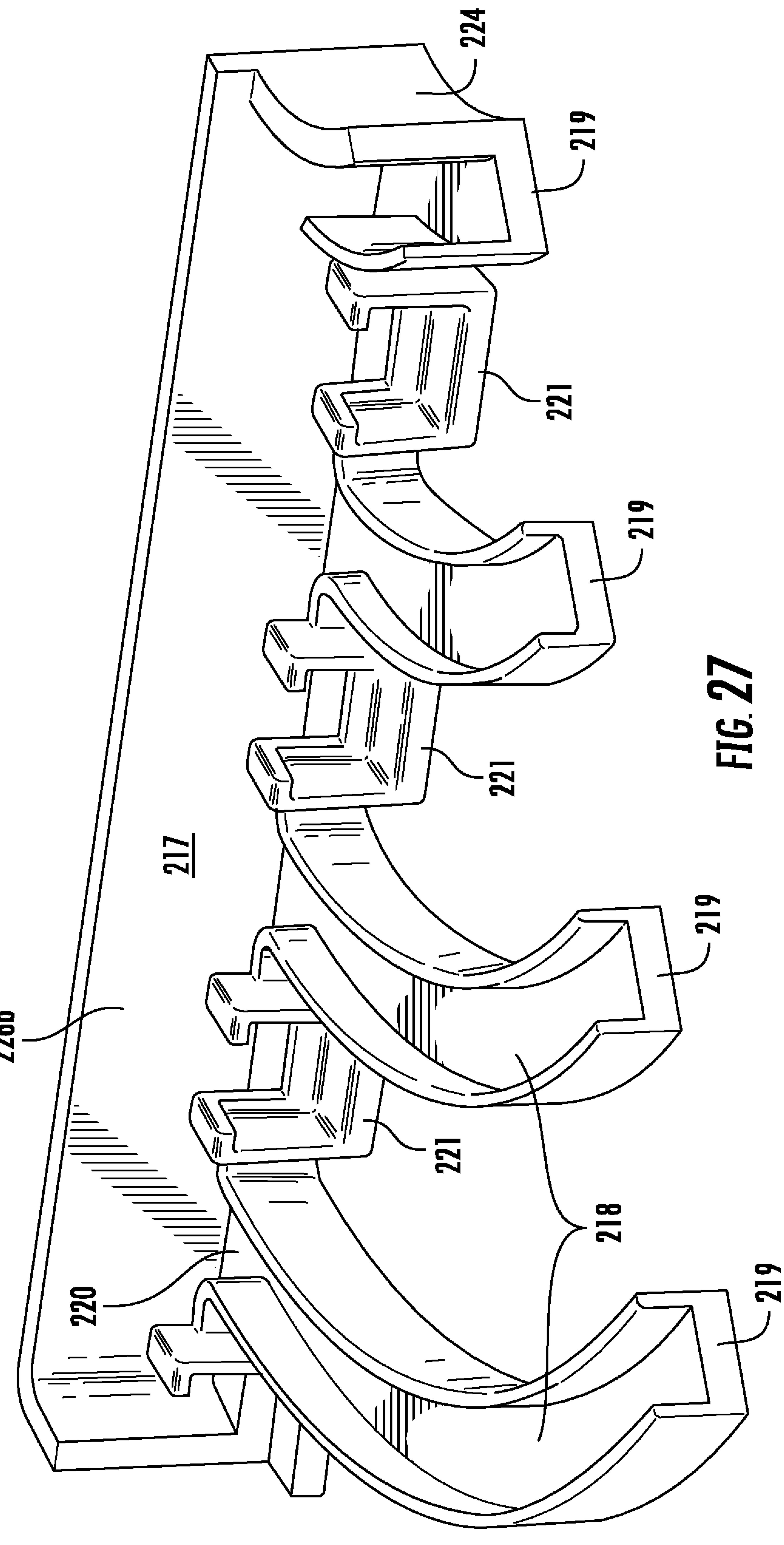
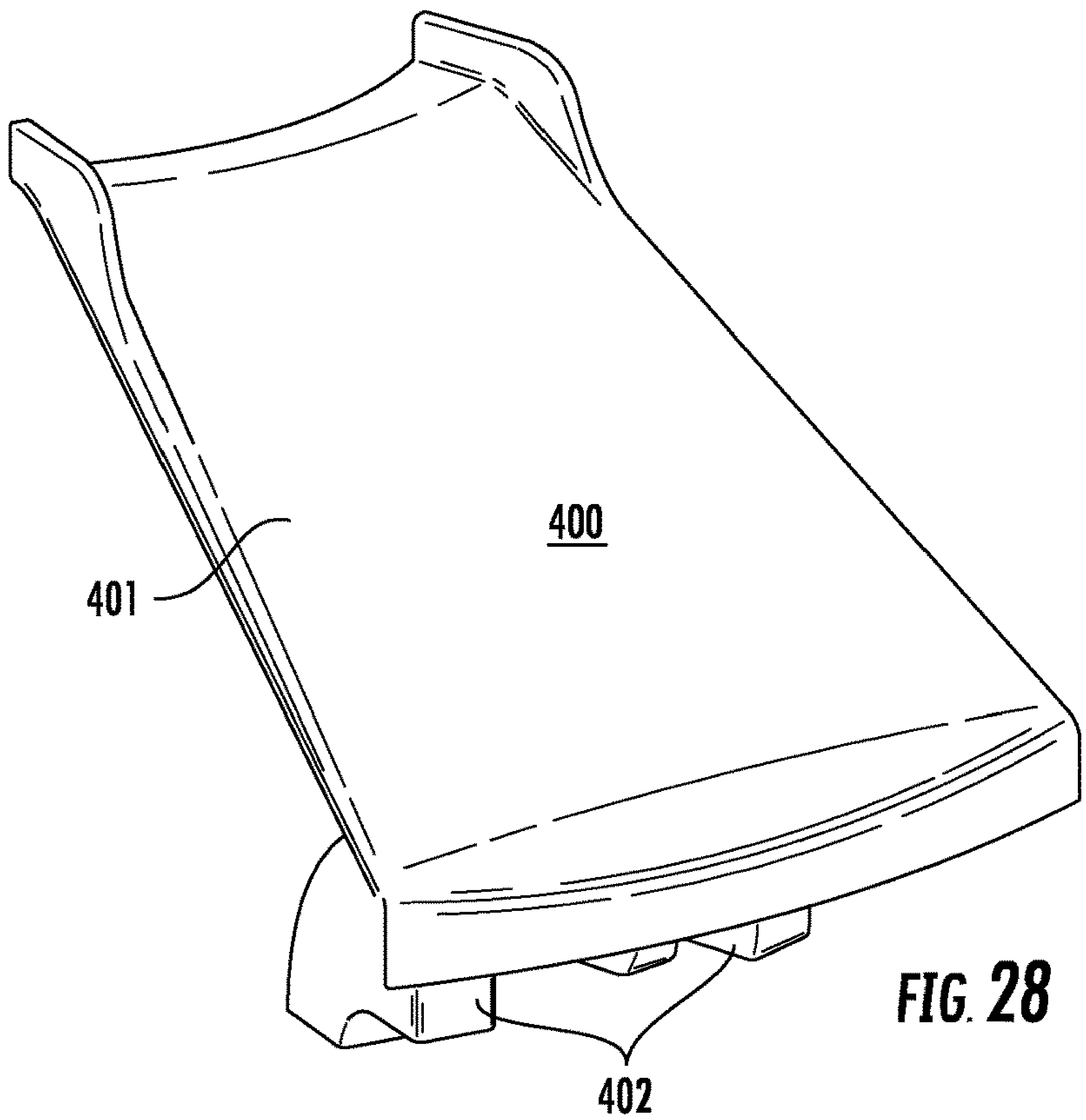


FIG. 27



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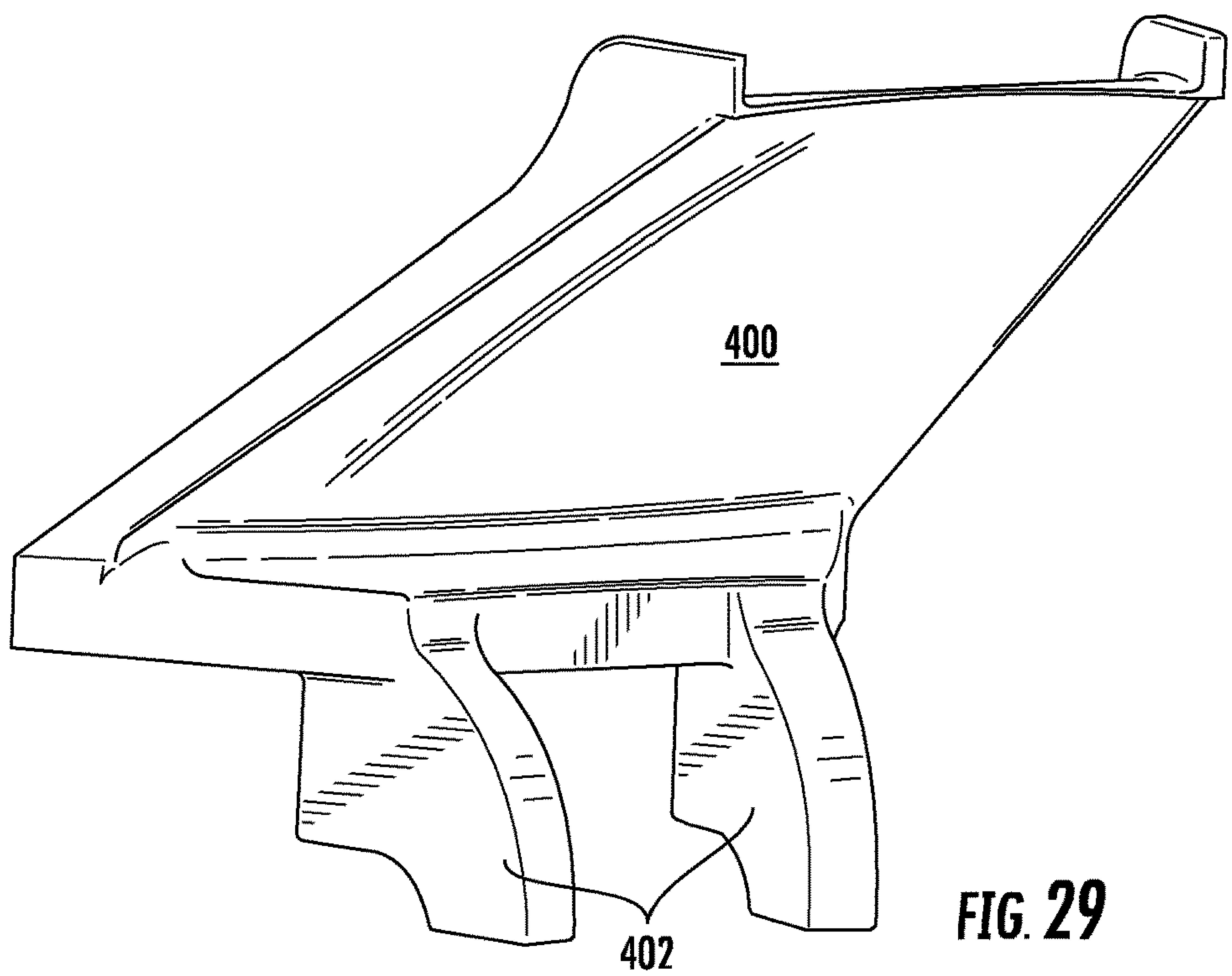

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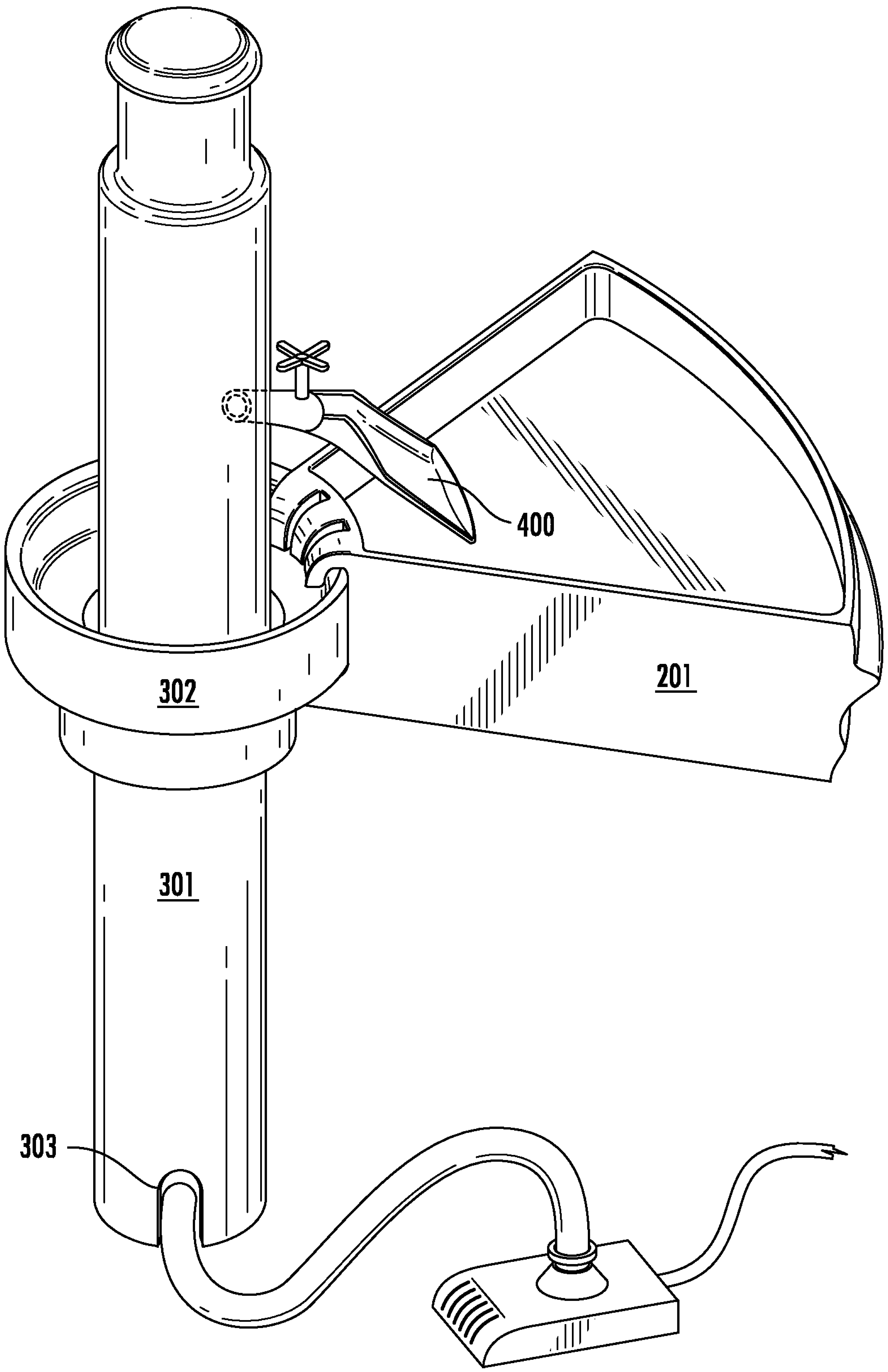

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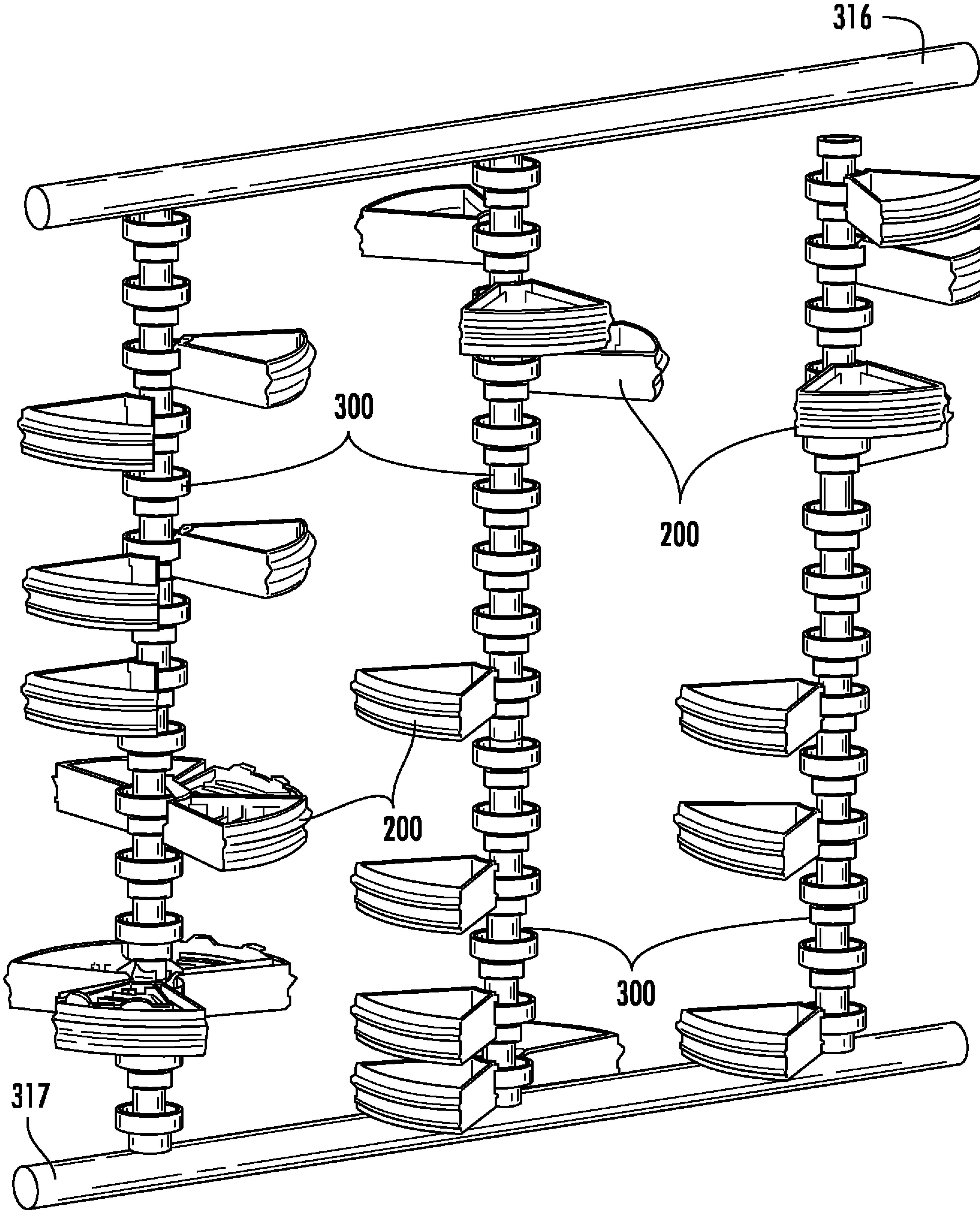


FIG. 31

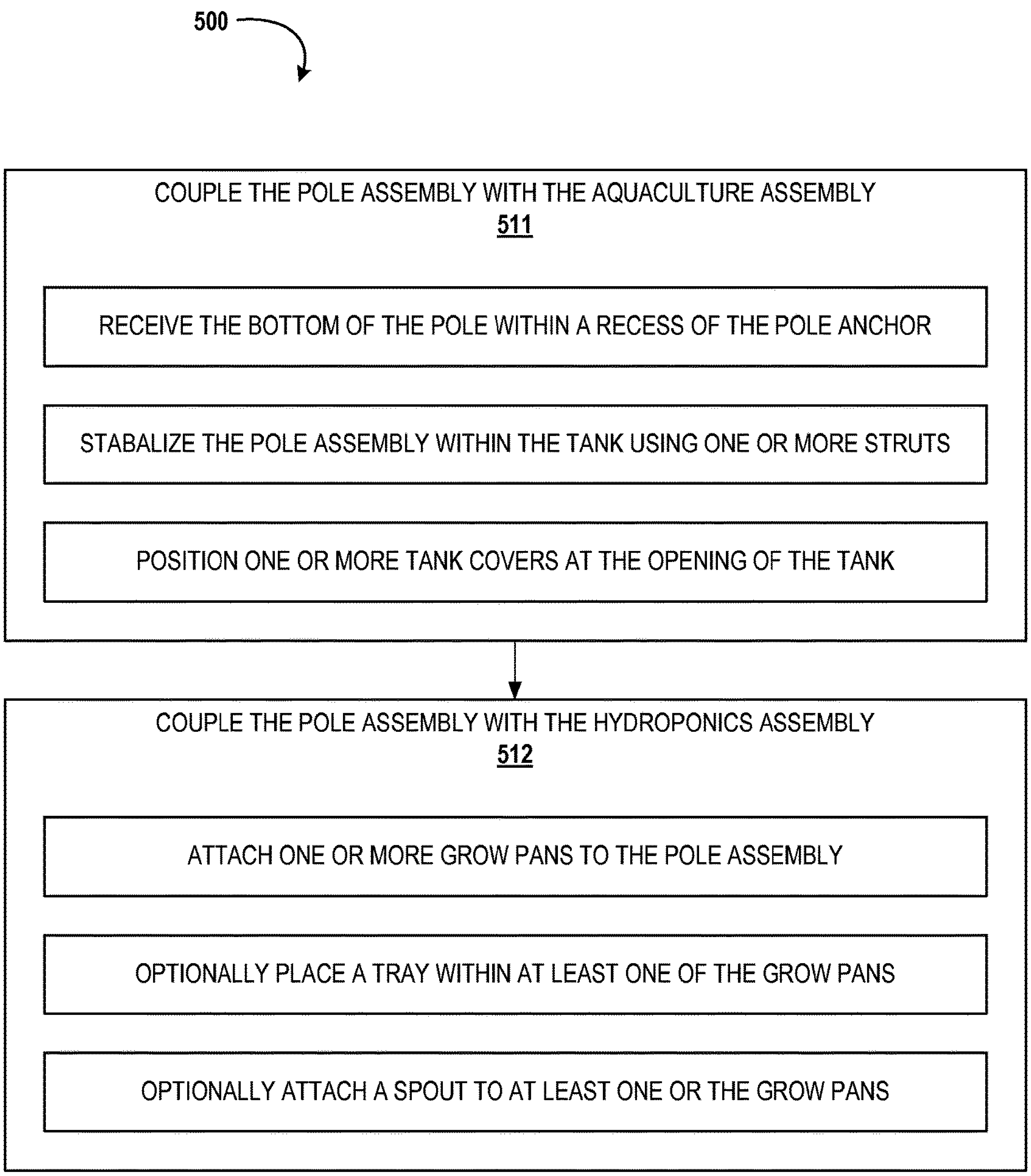

500
COUPLE THE POLE ASSEMBLY WITH THE AQUACULTURE ASSEMBLY
511
RECEIVE THE BOTTOM OF THE POLE WITHIN A RECESS OF THE POLE ANCHOR
STABALIZE THE POLE ASSEMBLY WITHIN THE TANK USING ONE OR MORE STRUTS
POSITION ONE OR MORE TANK COVERS AT THE OPENING OF THE TANK
COUPLE THE POLE ASSEMBLY WITH THE HYDROPONICS ASSEMBLY
512
ATTACH ONE OR MORE GROW PANS TO THE POLE ASSEMBLY
OPTIONALLY PLACE A TRAY WITHIN AT LEAST ONE OF THE GROW PANS
OPTIONALLY ATTACH A SPOUT TO AT LEAST ONE OR THE GROW PANS

FIG. 32

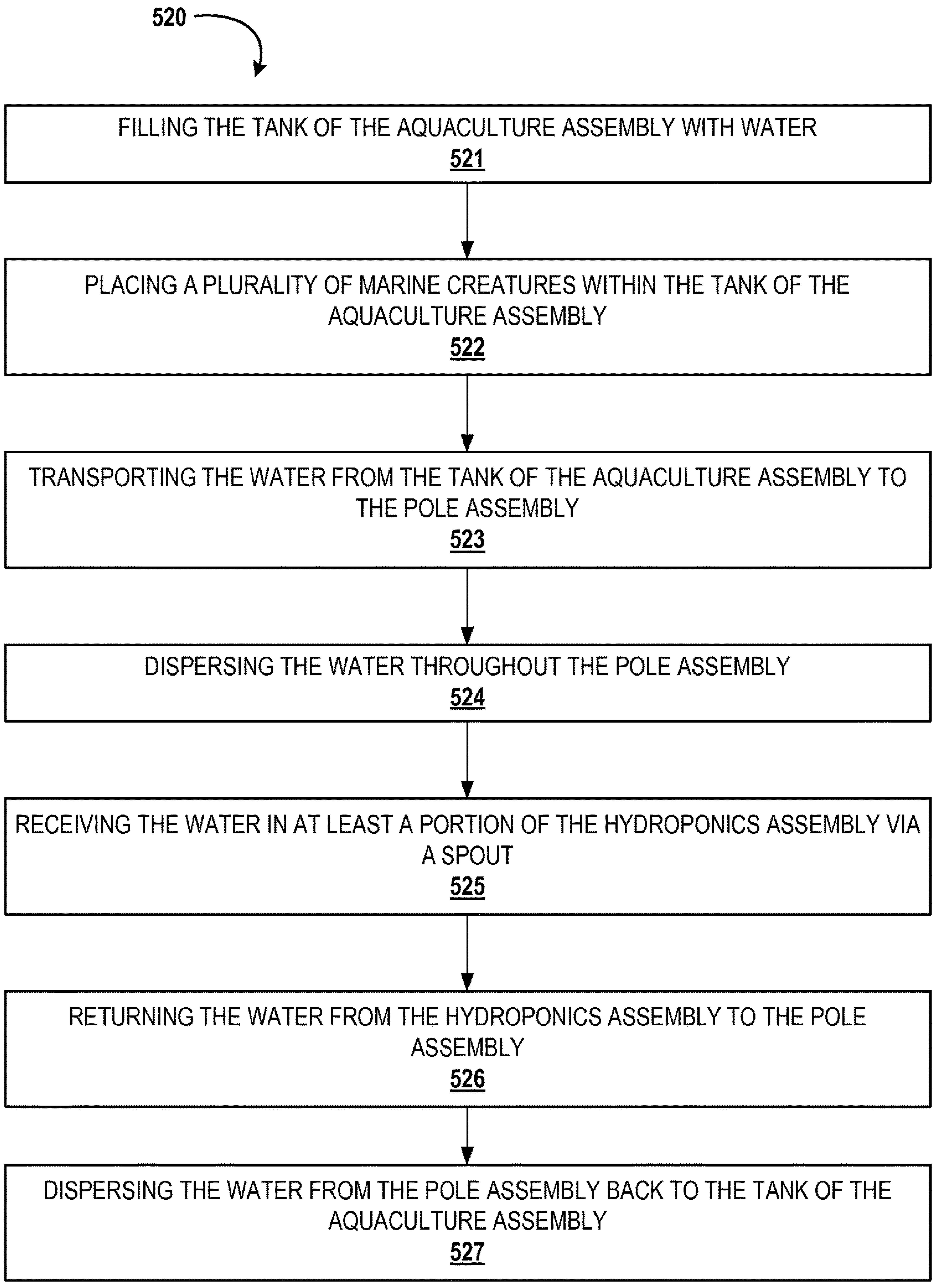
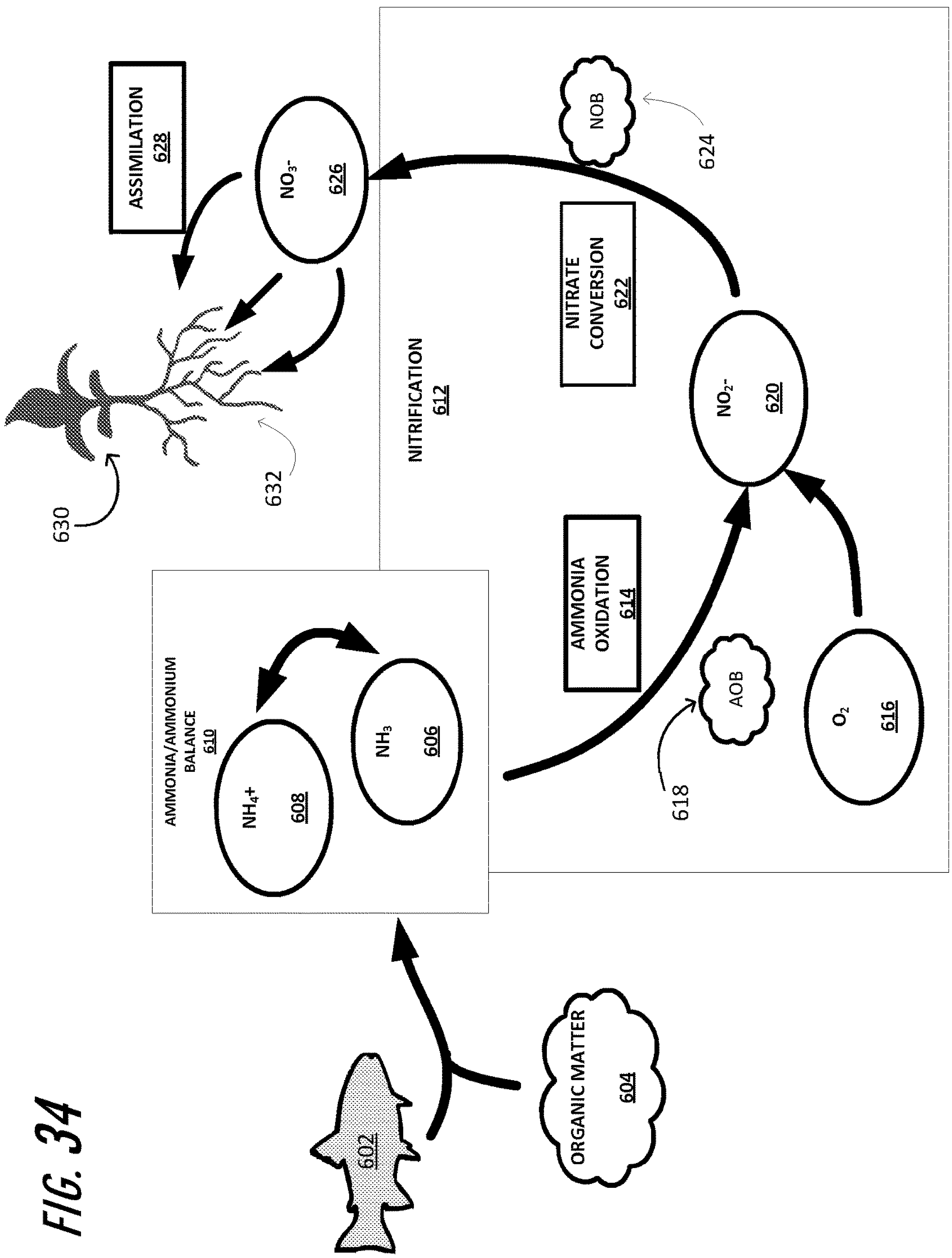

520
FILLING THE TANK OF THE AQUACULTURE ASSEMBLY WITH WATER
521
PLACING A PLURALITY OF MARINE CREATURES WITHIN THE TANK OF THE AQUACULTURE ASSEMBLY
522
TRANSPORTING THE WATER FROM THE TANK OF THE AQUACULTURE ASSEMBLY TO THE POLE ASSEMBLY
523
DISPERSING THE WATER THROUGHOUT THE POLE ASSEMBLY
524
RECEIVING THE WATER IN AT LEAST A PORTION OF THE HYDROPONICS ASSEMBLY VIA A SPOUT
525
RETURNING THE WATER FROM THE HYDROPONICS ASSEMBLY TO THE POLE ASSEMBLY
526
DISPERSING THE WATER FROM THE POLE ASSEMBLY BACK TO THE TANK OF THE AQUACULTURE ASSEMBLY
527

FIG. 33


ASSIMILATION
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NOB
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NITRATE CONVERSION
622
NITRIFICATION
612
NO_2^-
620
630
632
AMMONIA OXIDATION
614
AOB
618
O_2
616
AMMONIA/AMMONIUM BALANCE
610
NH_4^+
608
NH_3
606
602
ORGANIC MATTER
604

FIG. 34

AQUAPONICS SYSTEM

FIELD

This application relates generally to agriculture, and more particularly to systems (e.g., apparatuses, or the like) and methods for growing vegetation in both large and small scale hydroponic and/or aquaponic configurations.

BACKGROUND

Aquaponics is a vegetation (e.g., vegetables, herbs, spices, fruits, grasses, flowers, plants, or any other type of editable or non-editable vegetation) production system that combines supporting aquatic organisms (e.g., raising fish, snails, crayfish, prawns, or other like organisms in tanks) in aquaculture system with a hydroponic system (e.g., cultivating plants in water outside of the ground) in a symbiotic environment. The by-products (e.g., excretions and waste) from the animals being raised accumulate in tank, which increases the toxicity of the water in the tanks. The by-products are broken down by nitrogen-fixing bacteria into nitrates and nitrites, and the water is fed to the hydroponic systems where plants use the nitrates and nitrites as nutrients. The water is then recirculated back to the aquaculture system. Plants are grown as in hydroponics systems, with their roots immersed in the nutrient-rich water. These systems working together enable the ammonia that is toxic to the aquatic animals to be filtered out of the system, while at the same time providing nutrients to the plants. After the water has passed through the hydroponic subsystem, it is cleaned and oxygenated, and can return to the aquaculture tanks. This cycle is continuous.

As existing hydroponic and aquaculture farming techniques form the basis for all aquaponics systems, the size, complexity, and types of vegetation grown in an aquaponics systems can vary as much as any system found in either distinct farming discipline. Not all existing systems of aquaponics can be satisfactorily applied to indoor large and/or small scale use. Issues such as appearance, humidity, where the water is routed if a leak occurs, and adaptability for farming different types of vegetation are all considerations for indoor systems. The present invention addresses these needs by providing an aquaponics system that allows for the production of various types of vegetation, in various scales, and in various locations.

BRIEF SUMMARY

Embodiments of the invention are directed to systems (e.g., apparatuses) and methods for growing vegetation and/or support aquatic organisms, the system includes a pole assembly comprising one or more hydroponic assembly coupling locations, an aquaculture assembly comprising a water supply operatively coupled to the pole assembly; and one or more hydroponic assemblies. Each of the one or more hydroponic assemblies comprises a grow pan. The one or more hydroponic assemblies are operatively coupled to the pole assembly at the one or more hydroponic assembly coupling locations. The grow pan comprises a perimeter wall and receives water from the pole assembly adjacent a first portion of the perimeter wall, transfers the water to adjacent a second portion of the perimeter wall, and thereafter transfers the water back to the pole assembly. In some embodiments, the grow pan comprises an inner wall, and outer wall, and side walls, and the grow pan receives water from the pole assembly, transfers the water to adjacent the outer wall, and thereafter the water is transferred back to the pole assembly. The flow of water through the pan allows the water to travel over seeds or roots of vegetation.

In some embodiments, the pole assembly comprises a pole and the one or more hydroponic assembly coupling locations comprise one or more pole cups operatively coupled to the pole, and wherein the one or more hydroponic assemblies are operatively coupled to the one or more pole cups. In some embodiments, one or more pole cups affixed to the pole in a vertical orientation. In some embodiments, the aquaculture assembly comprises a tank having a pole anchor located therein, where the pole anchor is configured to receive a bottom portion of the pole, and a plurality of struts configured to stabilize the pole within the tank.

In some embodiments, the hydroponic assembly comprises one or more grow pans, wherein the one or more grow pans are operatively coupled with the pole assembly, and a tray operatively coupled at least one grow pan.

In some embodiments, the grow pan has a plurality of protrusions extending upward from the base of the grow pan.

In some embodiments, at least one of the one or more hydroponic assemblies comprises a tray operatively coupled to the grow pan.

In some embodiments, the tray comprises a first member and a second member that are operatively coupled with one another, wherein when the first member and the second member are operatively coupled with one another a plurality of tray channels are created within the tray, and wherein the first member and the second member may be dissembled to remove vegetation from the tray.

In some embodiments, the grow pan further comprises rails, wherein the tray is positioned along the rails, and wherein the tray is configured to slide along the rails to deliver water to the tray or grow pan in at least two positions.

In some embodiments, the tray is configured to slide along the rails to deliver water to the tray or grow pan, wherein in a first position water is delivered to the tray and subsequently dispersed from the tray to the grow pan, wherein in a second position water is delivered only to the grow pan, and wherein in a third position water is simultaneously delivered to both the tray and the grow pan.

In some embodiments, the perimeter wall comprises an inner wall, and outer wall, and side walls, and the water is transferred from the pole assembly adjacent the inner wall to adjacent the outer wall, and thereafter transferred back to the pole assembly adjacent the inner wall.

In some embodiments, channels are created between the side rails and the side walls of the grow pan, wherein the channels run from adjacent the outer wall and lead to openings in the inner wall of the grow pan, and wherein a base of the grow pan is sloped towards the outer wall such that the water flows along the base of the grow pan to adjacent the outer wall and back towards the pole assembly through the channels and exits the grow pan via the openings in the inner wall of the grow pan.

In some embodiments, channels are created between the side rails and the side walls of the grow pan, wherein the channels are sloped towards the outer wall, and wherein a base of the grow pan is sloped towards the pole assembly such that the water flows down the channels into the base of the grow pan adjacent the outer wall and back towards the pole assembly through the base of the gown pan and exits the grow pan via an opening in the inner wall of the grow pan.

In some embodiments, the aquaculture assembly comprises a tank having a pole anchor located therein, wherein the pole anchor is configured to receive a bottom portion of the pole, a plurality of struts configured to stabilize the pole within the tank, and at least one tank cover positioned at an opening of the tank.

In some embodiments, the aquaponics system comprises one or more spouts, wherein each of the one or more spouts are configured to deliver water from the pole assembly to each of the one or more hydroponic assemblies.

In some embodiments, the pole assembly further comprises a tube within the pole assembly, a pole cap operatively coupled to the tube and the pole assembly and comprising one or more exit slots, and wherein the water exits the pole assembly via the one or more exit slots, and wherein the pole cap increases water pressure within the tube.

In some embodiments, the one or more pole cups comprise an upper tier and a lower tier, and wherein the lower tier comprises one or more blades located between an outer surface of the pole and an inner surface of the lower tier. In some embodiments, the blades are sloped at an angle and configured to control the rate of water flow as water exits the lower tier of the pole cup.

In some embodiments, the one or more struts comprise a first end and a second end, wherein one of the one or more hydroponic assembly coupling locations is a pole cup, and wherein the first end is coupled to the pole cup and the second end is coupled with a ridge on an outer perimeter of the tank.

In some embodiments, the aquaponics system further comprises a pump and configured to pump water throughout the pole assembly.

In some embodiments, the pole anchor comprises a pole anchor access notch, and the bottom portion of the pole comprises a pole access notch, and wherein the pole anchor access notch is aligned with the pole access notch when the pole is received in a recess of the pole anchor such that the tube may pass through the access notches and be positioned within the interior of the pole.

In some embodiments, the pole assembly comprises a pole and the one or more hydroponic assembly coupling locations comprise one or more exit slots, wherein the grow pan of each of the one or more hydroponic assemblies are configured to be coupled with the pole via insertion into the exit slots, and wherein water flows directly from the pole into the grow pan.

Another embodiment of the invention comprises a system for growing vegetation. The system comprises a pole assembly comprising one or more hydroponic assembly coupling locations, an aquaculture assembly comprising a water supply operatively coupled to the pole assembly, and one or more hydroponic assemblies. Each of the one or more hydroponic assemblies comprises a grow pan, wherein the one or more hydroponic assemblies are operatively coupled to the pole assembly at the one or more hydroponic assembly coupling locations. The grow pan comprises an inner wall, and outer wall, and side walls and receives water from the pole assembly, transfers the water to adjacent the outer wall, and thereafter transfers the water back to the pole assembly. The flow of water through the pan allows the water to travel over seeds or roots of vegetation.

Another embodiment of the invention comprises an aquaponics system for growing vegetation. The aquaponics system comprises a pole assembly comprising a pole having one or more pole cups affixed to the pole in a vertical orientation. The aquaponics system further comprises an aquaculture assembly comprising a tank having a pole anchor located therein, wherein the pole anchor is configured to receive a bottom portion of the pole. The aquaponics also comprises a plurality of struts configured to stabilize the pole within the tank. Moreover, the aquaponics system comprises a hydroponic assembly comprising one or more grow pans, wherein the one or more grow pans are operatively coupled with the pole assembly, and a tray is operatively coupled at least one grow pan.

To the accomplishment the foregoing, the one or more embodiments comprise the features hereinafter described and particularly pointed out in the claims. The following description and the annexed drawings set forth certain illustrative features of the one or more embodiments. These features are indicative, however, of but a few of the various ways in which the principles of various embodiments may be employed, and this description is intended to include all such embodiments and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus described embodiments of the invention in general terms, reference will now be made to the accompanying drawings, where:

FIG. **1** depicts a perspective illustration of an aquaponics system, in accordance with one embodiment of the invention;

FIG. **2** depicts a perspective view of a tank as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **3** depicts a perspective view of a tank as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **4** depicts a perspective view of a strut as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **5** depicts a perspective view of a tank cover as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **6** depicts a perspective view of an aquaculture assembly as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **7** depicts a side view of the aquaculture assembly of FIG. **6**, in accordance with one embodiment of the invention;

FIG. **8** depicts a perspective view of an aquaculture assembly, in accordance with one embodiment of the invention;

FIG. **9** depicts a perspective view of a pole as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **10** depicts a perspective view of the bottom of a pole as illustrated in FIG. **9**, in accordance with one embodiment of the invention;

FIG. **11** depicts a perspective view of the top of a pole as illustrated in FIG. **9**, in accordance with one embodiment of the invention;

FIG. **12** depicts a side view of a pole cap as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **13**A depicts a perspective view of a pole assembly and a hydroponic assembly as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **13**B depicts a perspective view of a pole assembly and a hydroponic assembly as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **13**C depicts a perspective view of a pole assembly and a hydroponic assembly as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **13**D depicts a perspective view of a pole assembly and a hydroponic assembly as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **13**E depicts a perspective view of a pole assembly and a hydroponic assembly as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **14** depicts a partial cross-sectional side view of a pole assembly as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **15** depicts a top side view of a pan as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **16** depicts a bottom perspective side view of a pan as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **17**A depicts a perspective view of a pan as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **17**B depicts a pole assembly and a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **18**A depicts a perspective view of a pan as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **18**B depicts a pole assembly and a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **19** depicts a pole assembly and a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **20** depicts a pole assembly and a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **21** depicts a pole assembly and a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **22** depicts a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **23** depicts a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **24** depicts a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **25** depicts a perspective view of a tray as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **26** depicts a perspective view of a tray member as illustrated in FIG. **25**, in accordance with one embodiment of the invention;

FIG. **27** depicts a perspective view of a tray member as illustrated in FIG. **25**, in accordance with one embodiment of the invention;

FIG. **28** depicts a front side perspective view of a spout as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **29** depicts a rear side perspective view of a spout as illustrated in FIG. **1**, in accordance with one embodiment of the invention;

FIG. **30** depicts a pole assembly and a hydroponic assembly, in accordance with one embodiment of the invention;

FIG. **31** depicts a perspective view of a portion of an aquaponics system, in accordance with one embodiment of the invention;

FIG. **32** depicts a method of assembling the aquaponics system, in accordance with one embodiment of the invention;

FIG. **33** depicts a method of utilizing the aquaponics system, in accordance with one embodiment of the invention; and

FIG. **34** depicts a flow diagram illustrating how aquaponics systems work.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Embodiments of the present invention now may be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all, embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure may satisfy applicable legal requirements. Like numbers refer to like elements throughout.

FIGS. **1-30** illustrate embodiments of the aquaponics system **1**, and the various components thereof. As illustrated in FIG. **1**, the aquaponics system **1** comprises, in general, three assemblies: 1) an aquaculture assembly **100** and 2) one or more hydroponic assemblies **200** operatively coupled with the aquaculture assembly **100** via 3) a pole assembly **300**. The various assemblies, and components thereof, of the aquaponics system **1** of FIG. **1** are illustrated in FIGS. **2-31** and described in further detail throughout this specification. In general, the aquaculture assembly **100** is located at the base of the aquaponics system **1** and is configured for housing aquatic creatures in a controlled marine environment.

The aquaculture system **10** may comprise a tank **101** having a base plate **107** positioned at the bottom of the tank **101**, and one or more tank covers **114** positioned at the opening of the tank **101**. The pole assembly **300** is at least partially submerged in the tank **101** and extends generally vertically from the base plate **107** of the tank **101** in an upright orientation. The pole assembly **300** (or additional components within) is configured for supplying water from the aquaculture assembly **100** to the hydroponic assemblies **200**, and is further configured to control the flow of water as it dispenses to and from the hydroponic assemblies **200**, and thereafter returns to the aquaculture assembly **100**.

The pole assembly **300** may comprise a pole **301**, a plurality of pole cups **305** located vertically along the pole **301**, and a pole cap **312** or one or more openings **304** positioned at the top of the pole **301**. The hydroponic assemblies **200** may be operatively coupled to the pole assembly **300** and configured for housing plants in a controlled growing environment wherein the hydroponic assemblies **200** may receive water from the pole assembly **300** via a plurality of spouts **400** or various other means described in further detail later. The pole assembly may further comprise one or more hydroponic assembly locations located vertically about the pole and configured to receive the hydroponic assemblies **200**. In a preferred embodiment, the pole cups **305** function as hydroponic assembly coupling locations; however, in other embodiments, the pole **301** itself may be a hydroponic assembly coupling location such that the hydroponic assemblies **200** may be operatively coupled with the pole assembly **300** at any location and in any orientation about the vertical axis of the pole **301** using various couplings mechanisms (e.g., slotted holes through the pole and a tab or hook on the pan, an apron or lip on the pole and a tab or hook on the pan, slots or groves on the surface of the pole and a projection on that pan that slides within the slots or grooves, or any other type of coupling).

The hydroponic assemblies **200** may comprise one or more pans **201** wherein the pans **201** may optionally have a tray **215** operatively coupled to the pans **201**, which may be deposited within the pans **201**, located on top of the pans **201**, span an opening in the pans **201**, or otherwise be attached to the pans **201**. In some embodiments, the aquaponics system **1** may include an optional tube (not illustrated) located within the pole **301** to supply water from the aquaculture assembly **100**, throughout the pole **301**, and to the hydroponic assemblies **200**.

With respect to FIG. **1**, and as discussed in further detail throughout this specification water is pumped up through the pole **301** (e.g., a tube within the pole **301** or through the pole **301** itself) and exits the pole cap **312** or one or more openings **304** at or near the top of the pole **301**. The water flows down the outside surface of the pole **301** and is diverted by the spouts **400**, which direct the water from the outside surface of the pole **301** to the pans **201** and/or trays **215**. As will be discussed in further detail later the water will either flow into the tray **215** and then into the back of the pan **201**, or flow directly into the back of the pan **201** in order to provide a continuous stream of water to the plants in the pans **201** and/or trays **215**. The water on the bottom of the pan **201** then flows back to the pole **301** and/or cup **305** and is collected in a second cup **305** located vertically below the first cup **305**. The cup **305** funnels the water back to the outside surface of the pole **301** for delivery to a second pan **201** and/or tray **215** located below the first pan **201** and/or tray **215**. The water then flows back to the tank **101** and the process begins again.

FIGS. **2** through **8** illustrate the aquaculture assembly **100** and its components in accordance with one embodiment of the invention. As illustrated in FIGS. **2** through **8** the aquaculture assembly **100** comprises a tank **101** having a base plate **107** adjacent to the bottom of the tank **101**, and one or more tank covers **114** adjacent to the opening **103** of the tank **101**, wherein the tank covers **114** may be positioned at or above an outer perimeter of the tank **101** using a plurality of struts **120**.

As illustrated in FIGS. **2** through **3**, the tank **101** may be defined by a cylindrical reservoir that has a base **102**, an opening **103**, and a perimeter wall **104**. The outer perimeter of the base **102** may be adjacent to bottom edge of the perimeter wall **104** such that the opening **103** is defined by a recess formed therein. The opening **103** may further have an outermost perimeter **105** that is defined by the top edge of the perimeter wall **104** of the tank **101**. The tank **101** may additionally comprise one or more ridges **106** that extend outwardly from the perimeter **105** of the tank opening **103** such that the ridges **106** are configured for receiving at least a portion of the struts **120** to stabilize the pole **301** within the tank **101**. For example, as shown in FIG. **2** and FIG. **3**, the tank **101** may comprise three (3) ridges **106** that are equally distanced from one another, along the perimeter **105** of the tank opening **103**, and slightly extend outward beyond the perimeter wall of the tank **101***c*. As illustrated in FIG. **1** and FIG. **7**, the ridges **106** are configured to receive at least three (3) struts **120**, where one (1) strut **120** is operatively coupled with one (1) corresponding ridge **106**. It should be noted that although in some embodiments the tank **101** is defined by a cylindrical shape, the tank **101** may be embodied by other shapes that are illustrated and are not illustrated herein, including but not limited to, cubed, rectangular, trapezoidal, and/or organic or ameba shapes. In said embodiments, the tank **101** may have a plurality of perimeter walls as opposed to the one continuous perimeter wall **104** shown in the illustrated embodiments. For example, as shown in FIG. **8**, the tank **101** may be rectangular in shape such that it comprises four (4) perimeter walls and four (4) corresponding tank ridges configured to receive struts **120** and stabilize the pole assembly **300** within the tank **101**. It should be understood that any size and shape may be utilized for the tank **101** within the aquaponics system **1**. As further illustrated in FIG. **8**, in some embodiments, the struts **120** may be adjustable to accommodate a variety of tank **101** shapes. In such an embodiment, the struts **120** may be embodied by two individual members that can be coupled with each other using a fastener **120***a* and/or another coupling mechanism. In this way the struts **120** may be retractable and/or extendable based on the size of the tank. In some embodiments, the system may use a combination of static (one size) and dynamic (retractable and/or extendable) struts **120**.

As further illustrated in FIGS. **2** through **8**, the base plate **107** may be positioned adjacent to the base **102** of the tank **101** such that the base plate **107** rests above the base **102** of the tank **101**. The base plate **107** may be defined by a circular shaped plate that comprises a pole anchor **108** that extends upwardly from the center of the base plate **107**. In other embodiments, the base plate **107** may be of a thickness that allows the pole anchor **108** to extend inwardly into the base plate **107**. In one embodiment, the base plate **107** is a plate that is removably coupled with the base **102** of the tank, and in another embodiment, the base plate **107** is integral within the base **102** of the tank **101** itself. The pole anchor **108** may be operatively coupled with the base plate **107** (e.g., glued, locked into place, formed integrally within, or otherwise secured to the base plate **107**). As shown in FIG. **2** and FIG. **3**, the base plate **107** may reflect the shape of the tank **101** such that in other embodiments the base plate **107** may be embodied by other shapes not illustrated herein, including but not limited to, cubed, rectangular, trapezoidal, and/or organic or ameba shapes. Additionally, in other embodiments, the base plate **107** may be defined by a shape that is different from the shape of the tank **101**. For example, a rectangular tank **101** may comprise a circular base plate **107** therein.

The pole anchor **108** within the base plate **107** may be defined by a recess **109**, an access notch **110**, an inner wall **111**, an outer wall **112**, and/or a top edge **113**. The recess **109** may be centered in the middle of the pole anchor **108** and configured for receiving the bottom of a pole **301** such that the pole **301** is stabilized in an upright position after being placed into the recess **109**. To this extent, the shape and size of the recess **109** may be defined by the inner wall **111** of the pole anchor **108** such that it reflects the shape of the pole **301**. Additionally, the pole anchor **108** may have an access notch **110** that extends from the inner wall of the pole anchor **111** to the outer wall of the pole anchor **112**. The access notch **110** may allow for an optional tube to pass through the pole anchor **108** and be redirected into the pole **301** permitting the tube to supply water from the aquaculture assembly **100**, throughout the pole assembly **31** and, to the hydroponic assemblies **200**. In some embodiments, as illustrated at least in FIGS. **13***a*-**13***b* and FIG. **30**, the tube may be connected to a pumping mechanism that pumps water, from the aquaculture assembly **100**, into the tube. As such in an alternative embodiment, the access notch **110** may be omitted and the base plate **107** may further comprise a hole in the bottom of the base plate **107** that aligns with the hole of the an opening in the bottom of the pole **301** to permit the supply water into the pole assembly **300**.

As illustrated in FIG. **4**, the struts **120** may be several elongate structures that are configured for bracing the pole **301** after it has been operatively coupled with the base **102** of the tank **101** (e.g., through the pole anchor **108**). As shown in the illustrated embodiments, the struts **120** may be at least partially defined by a first end **121** and a second end **122** that are operatively coupled (e.g., configured to connect and/or fasten the struts **120**) to the pole assembly **300** and the tank **101**. In one specific embodiment, the first end **121** of the strut **120** may fasten to at least a portion of the pole cup **305**, and the second end **122** may fasten to a ridge **106** of the tank **101** such that the pole **301** is stabilized in an upright position and less likely to be deflected out of the generally vertically orientation. As such the height of the pole cup **305** with respect to the ground (e.g., when installed into the pole anchor **108**) may be equivalent to the height of the tank **101**. Furthermore, the first and second ends of the struts (**120**a, **120**b, respectively) may comprise grooves and/or other coupling mechanisms that allow the ends to fasten and conform to either a hydroponic assembly the pole cups **305**, or a ridge **106** of the tank **101**. In some embodiments, the struts **120** may be positioned such that they are equally distanced from one another and exert an equivalent force on both the pole **301** and the tank **101**.

The struts **120** may be further defined by at least one or more indentations **123** (e.g., rails, shelves, cover supports, or the like), in the top surface of the strut **120**, for receiving the tank cover **114**. As shown in FIG. **4**, in one embodiment where the tank **101** has multiple tank covers **114**, the strut **120** may comprise two (2) indentations **123**. FIG. **1** further illustrates where, in such an embodiment, at least a portion of a first tank cover **114** may be positioned adjacent to the first indentation **123** and a at least a portion of a second tank cover **114** may be positioned adjacent to the second indentation **123** such that the top surfaces of the tank covers **114** are flush with the top surface of the strut **120**. In another embodiment where the tank **101** has a single tank cover **114**, the strut **120** may comprise only one (1) indentation **123** configured to receive at least a portion of the tank cover **114** therein. In one embodiment, the length of the strut **120** may be equivalent to the distance from the ridge of the tank **106** to an edge of the cup **305** on the pole **301**. In one embodiment, as illustrated in FIG. **1**, where the tank **101** is cylindrical in shape, the length of the strut **120** may be less than the radius of the tank **101**. In another embodiment, as illustrated in FIG. **8**, where the tank **101** is rectangular in shape, the length of the struts **120** may vary with respect to the distance between the tank wall and the edge of the cup **305** of the pole **301**. For example, the length of two of the struts **120** (out of the four struts **120** illustrated in FIG. **8**) operatively coupled to the rectangular tank **101** with respect to its width may be sustainably less than the length of two of the struts **120** applied to the tank with respect to its length. It should be understood that any type of strut **120** may be utilized in order to help support the pole **301** within the tank **101**.

As illustrated in FIG. **5**, the one or more tank covers **114** may be embodied by flat plates that are configured to be positioned adjacent to the opening **103** of the tank **101** using one or more struts **120** such that the top surface of the tank covers **114** are flush with the top surface of the struts **120** and/or the opening perimeter **105** of the tank **101**. As show in FIG. **5**, in one embodiment, the tank covers **114** may comprise several notches **115** on the corners of each of the individual tank covers **114** that allow that covers **114** to be received in the indentations **123** within the top surface of the struts **120**. In this configuration, the inner edges of the tank covers **117** are adjacent to the pole **301**, the outer edges of the tank covers **118** are adjacent to the opening perimeter of the tank **105**, and the side edges **119** are positioned adjacent to barriers that separate the indentations **123** in the top surface of the struts **120**. In the illustrated embodiments, the area **116** of the tank cover **114** that extends from the notches **115** is equivalent to the area of the indentation **123** within the top surface of the struts **120** such that when positioned adjacent to the top of the strut the tank covers **114** fit securely in place. In an embodiment, where the tank **101** is cylindrical in shape and comprises several tank covers **114**, the tank covers **114** may be arc shaped such that when positioned at the opening of the tank **103** the covers **114** conceal a majority portion of the opening of the tank **103**. In one embodiment, the tank **101** may comprise a single tank cover **114** such that when positioned adjacent to the opening **103** of the tank **101** using the one or more struts **120** the top surface of the tank covers **114** rest above the top surface of the struts **120**. The tank covers **114** may additionally comprise notches located along the outer boundary of the tank cover **114** and adjacent to the opening perimeter of the tank **101**d that allow for visibility into the tank **101** as well as a means to easily remove and place the tank cover **114** on top of the struts **120**, feed any organisms living the tank, supply nutrients to the water, or the like.

FIGS. **9** through **14** illustrate a pole assembly **300** in accordance with embodiments of the invention. As illustrated in FIGS. **9** through **14** the pole assembly **300** may comprise a pole **301** having one or more pole cups **305** arranged about the pole **301** in a vertical orientation, and a pole cap **312** or opening **304** located at the top of the pole **301**, wherein the pole cap **312** is at least partially coupled with the pole **301**.

As illustrated in FIGS. **9** through **14**, the pole **301** may be defined by an elongate conduit that has a pole extension **302** at the top of the pole **301**, an access notch **303** located at the bottom of the pole, and an opening **304** located at the top of the pole. The access notch **303** may be provided for allowing the passage of an optional tube into the pole **301** such that the tube may supply water from the aquaculture assembly **100**, throughout the pole **301** and, to the hydroponic assemblies **200**. In an embodiment, as illustrated in FIG. **7**, the bottom of the pole **301** is positioned in the pole anchor **108** of the base plate **107** such that the base plate access notch **110** and the pole access notch **303** are aligned with one another and form an opening that extends from the tank opening **103** to the interior of the pole **301**.

The pole extension **302** may be slightly narrower than the pole **301** such that it can be coupled with a pole cap **312**. In this regard, as illustrated in FIG. **1**, the pole cap **312** may be configured to receive the pole extension **302** in an opening of the pole cap **312**. The pole cap **312** may have a plurality of exit slots **313** located at the top of the pole cap **312** that allow the water to exit the interior of the pole and be distributed to the outside surface of the pole **301**, the spouts **400**, the hydroponics assemblies **200**, back to the pole cups **305**, and back down outside surface of the pole **301**. To this extent the size of the openings of the exit slots **313** may allow the water to flow at a controlled rate as it exits the pole **301**. The pole cap **312** also prevents water from shooting strait into the air, and may also have channel surfaces **315** to transition the water to the outside surface of the pole **301**.

In an alternative embodiment, as shown in FIG. **13**A, the exit slots **317** may be located in the pole **301** itself versus being in the pole cap **312**. In one embodiment, the exit slots **317** may be a fixed size. However, in other embodiments the size of the exit slots **317** may be adjusted to smaller increments, and/or the exit slots **317** may be manually or automatically opened or closed such the flow of the water may be regulated with a slider located either inside or outside the pole **301** or pole cap **312**. The pole cap **312** may be provided to increase or decrease the pressure within the pole **301** and/or the tube that may run inside of the pole **301**. As such, the pole cap **312** may be adjusted to increase or decrease the flow of water that is allowed to exit the pole **301** (or tube within the pole **301**).

In one embodiment, the pole cap **312** may additionally have an opening **314** for receiving a fastener (e.g. a screw, or the like) to secure the pole cap **312** to the pole **301** and/or the tube. In this regard, both the pole cap **312** and the pole **301** and/or the tube may have an opening **314** that is internally threaded such that the openings **314** can be aligned with one another and receive a fastener. In another embodiment, the pole cap **312** may screw directly onto the pole **301**. To this extent, at least a portion of the pole cap **312** may be internally threaded, and at least a portion of the pole extension **302** may be externally threaded such that the pole extension **302** is configured to receive the pole cap **312**. In yet another embodiment, the pole cap **312** snaps, slides, clips, or the like onto the pole extension **31** such that it is secured in place and no additional threading is necessary. In an alternative embodiment, the pole cap **312** may be omitted from the design and the pole assembly **300** may use an alternative means for building pressure within the pole **301** and controlling the flow of water out of the pole **301**. For example, as shown in FIG. **13**, the top of the pole **301** may be enclosed versus having an opening, and the pole may comprise several exit slots **317** to allow water to exit the pole **301**.

As further illustrated in at least FIGS. **9** through **11**, the pole **301** may comprise one or more pole cups **305** that are arranged along the pole **301** with respect to its vertical axis. The one or more pole cups **305** may be divided into upper and lower tiers (**306**, **307**, respectively). The upper tier **306** of the pole cup **305** may be configured for receiving an overflow of water as it is being dispersed from another area within the system (e.g., a pole cup **305** located above) and funneling the water to the lower tier **307** of the pole cup **305*b***. As shown in FIGS. **9** through **11**, in one embodiment, the lower tier **307** may be narrower than the upper tier **306**. It should be noted that although in the illustrated embodiments, the pole cups **305** are generally circular in shape, the pole may be embodied by other shapes not illustrated herein, including but not limited to, cubed, rectangular, trapezoidal, and/or organic or ameba shapes. The pole assembly **300** may additionally comprise a plurality of blades **311** (e.g., also described as fans, diffusers, diverters, or like) that control the rate at which the water exits the lower tier of the cup and flows down the pole to the hydroponic assembly **200**, another cup **305**, or to the aquaponics tank **101**. In a preferred embodiment, as illustrated in FIG. **10**, the blades **311** may be located between the outer perimeter of the pole **301** and the inner perimeter of the lower tier **307** of the cup **305**. The blades **311** may extend outward from the outer perimeter of the pole **301** until they reach the inner perimeter of the lower tier **307** of the cup **305** and upward such that the blades **311** are angled and/or sloped with respect to the ground level. The blades **311** may further be angled towards the direction of the outer surface of the pole **301** to help direct the water onto the surface of the pole **301**. It should be noted that the blades **311** may be positioned in other configurations not shown in the illustrated embodiments such that the configuration of the blades **311** may vary the rate of flow of the water (e.g., slow down or speed up the flow of water).

In one embodiment, the one or more pole cups **305** may be permanently coupled to the pole **301**, for example formed integrally with the pole **301** (e.g. molded, plastic welded, or the like) or permanently secured to the pole **301**. The pole cups **305** may be located at the desired height in order to space apart the pans **201** to grow different types of plants or other vegetation (e.g., vegetables, herbs, spices, fruits, grasses, flowers, plants, or any other type of editable or non-editable vegetation). In another embodiment, as shown in FIG. **14**, the one or more pole cups **305** may be removably coupled to the pole **301**. In an embodiment, where the pole cups **305** are removable the pole cups **305** may further comprise a hook and/or clasp mechanism to connect the cup **305** to the pole **301**. In one example, a half section of the cup is removable by detaching a hook **308** on a first end of the pole cup **305** from the attachment point **309** located on the second and/or opposite end of an adjacent pole cup **305**. It should be that, although a hook and/or clasp mechanism is shown in the illustrated embodiment, other methods may be used to secure to two halves of the pole cup **305** and pole **301** together including other fasteners (e.g. screws). The pole cup **305** may further comprise inner bracing **310** to stabilize the pole cup **305** as it is attached to the pole **301**. Additionally, the pole **301** may be asymmetrically configured such that it is defined by a series of curvatures where the "in and out" orientation of the curves prevents the pole cup **305** from easily sliding down the pole **301**. It should be noted that although in the illustrated embodiments, the pole is generally cylindrical in shape, the pole may be embodied by other shapes not illustrated herein, including but not limited to, cubed, rectangular, trapezoidal, and/or organic or ameba shapes.

In other embodiments of the invention the pole cup **305** may slide over the pole **301**, and a section of the pole cup **305** may be tightened, secured to with a faster, or otherwise be attached to the pole **301**. In still other embodiments, the diameter of the pole **301** may increase gradually or may otherwise have different diameters along the pole **301**, such that pole cuts with different diameter holes may be placed over the top of the pole **301** and located on the pole **301** based on the diameter of the pole **301** and the inner diameter of the pole cup **305**.

FIGS. **15** through **26** illustrate the hydroponic assembly **200** in accordance with various embodiments of the invention. As illustrated in FIGS. **15** through **26** the hydroponic assembly **200** comprises one or more grow pans **201**, wherein the grow pans may optionally have a tray **215** placed within the pan **201**.

As illustrated in FIGS. **15** through **27**, the grow pan **201** may be defined by a pan that has a plurality of protrusions **202** extending upward from the base of the pan **201**, at least one channel **205** having a channel opening **206**, at least one sloped surface **207** in the base of the pan **201*b***, one or more hooks **208**, and side rails **209**. As shown in the Figures, in one embodiment, the pan **201** may be further defined by walls that extend upward from the base of the pan **201**. The pan **201** may comprise an inner wall **212**, an outer wall **213**, and two side walls **214*a***, **214*b*** that collectively form an opening in the top of the pan.

In one embodiment, the side rails **209** may be located parallel to the interior of the side walls **214*a***, **214*b*** such that two channels **205*a***, **205*b*** are formed. In the illustrated embodiments, a first channel **205*a*** is formed on the left side of the pan **201**, and a second channel **205*b*** is formed on the right side of the pan. However, in other embodiments, the pan may comprise only one side rail **209** such that only one channel **205** is formed. The side rails **209*a***, **209*b*** may comprise an inner edge **210** and an outer edge **211**, where the inner edge **210** is adjacent to the inner wall **212** of the pan **201**, and the side rails **209*a***, **209*b*** may extend from the inner wall **212** of the pan **201** until the outer edge **211** of the side rail **209** is adjacent (e.g., within a short distance of) the outer wall **213** of the pan **201** such that a gap is formed between the outer edge **211** of the side rail **209** and the outer wall **213** of the pan **201**. Each channel **205*a***, **205*b*** may lead to a channel opening **206***a*, **206***b* that is formed in the inner wall **212** of the pan **201** that opens to external surface of the pole cup **305** or the external surface of the pole **301**.

As such, in one embodiment of the invention, as water flows into the base of the pan **201** the water is first directed to the outer wall **213** because the base is sloped towards the outer wall, flows through the gaps, and back down the one or more channels **205***a*, **205***b* towards the pole **301** because the channels **205***a*, **205***b* are sloped towards the pole **301**. As such, the pan **201** provides a means for water to continuously enter the base of the pan **201**, flow over the seeds or roots of the plants or other vegetation towards the outer wall **213**, and back towards the inner wall **212** adjacent the pole **301** through the channels **205***a*, **205***b*.

In one embodiment, upon exiting the pan **201** the water may flow towards the exterior of the lower tier **307** of a pole cup **305** and travel down the exterior of the pole cup **305** and subsequently continue to flow down the pole **301**. In another embodiment, the lower tier **307** of a pole cup **305** may comprise an opening adjacent to the channel opening such that the water flows directly into the interior of the lower tier **307** of the pole cup **305** and through the plurality of blades **311** before exiting the pole cup **305**. The pan **201** may additionally comprise at least one sloped surface **207** in the base **203** of the pan **201** that defines the direction in which the water should flow. For example, as shown in the illustrated embodiments of FIGS. **15-18**, the pan may comprise two sloped surfaces (**207***a*, **207***b*) that extend into the base **203** of the pan at an angled depth such that it creates an incline in the channels **205***a*, **205***b*, where the channels **205***a*, **205***b* slope downward from the outer wall **213** towards the inner wall **212** of the pan allowing water easily to flow towards the pole **301**. Likewise, in some embodiments, a similar inclination may be created in base **203** of the pan **201** such that the base slopes downward from the inner wall **212** towards the outer wall **213** of the pan allowing water to flow towards the outer wall **213** of the pan **201** and subsequently into the at least one channel **205**. In yet another embodiment, the base may be defined by a flat surface that extends from the inner wall **212** of the pan **201** to the outer wall **213** of the pan **201**.

In another embodiment, as shown in FIG. **22**, two channels (**205***a*, **205***b*, respectively) may be formed adjacent to the top edges of the side walls (**214***a*, **214***b*) of the pan on the left and right sides versus the in the base **203** of the pan, wherein the channels **205** may be adjacent to the interior of the side walls **214***a*, **214***b* (side rails **209***a*, **209***b*, and protrusions **202** not illustrated). In such an embodiment, the channels **205***a*, **205***b* may carry the water towards to outer wall **213** of the pan on each side the water may then over flow at the end of the channel **205** and enter the base **203** of the pan, wherein the base **203** of the pan **201** is sloped towards the pole assembly **300** such that the water flows towards the pole assembly **300** and exits the pan **201** through an opening **206** in the inner wall of the pan **201**. In other embodiments there may be other types of channels located within the pan **201** to deliver the water toward a location adjacent the outer wall **213** of the pan **201** and back towards the inner wall **212** of the pan **201**.

In yet another embodiment, as shown in FIG. **23**, the water may travel throughout the hydroponic assembly **200** and back to the pole assembly **300** without the use of the one or more channels **205** in the pan **201**. As illustrated a first layer in the pan **201** may direct the water flow to the back of the pan (e.g., towards the outer wall **213**) and a lower layer in the pan **201** may direct the water back to the inner wall **212** of the pan **201**. The first layer in the pan **201** may also have protrusions **202** (not illustrated) as illustrated in FIGS. **15-20**, or the like.

In another embodiment, as shown in FIG. **24**, one channels **205** may be formed adjacent to the top edges of a side walls of the pan **201** on either the left and right sides versus the in the base **203** of the pan, wherein the channel **205** may be adjacent to the interior of the side walls **214** (side rails **209**, and protrusions **202** not illustrated). In such an embodiment, the channel **205** may carry the water towards the outer wall **213** of the pan such that the water over flows at the end of the channel **205** and at the interior sides of the channel **205** and enters the base **203** of the pan, wherein the base **203** of the pan **201** is sloped downward away from the channel **205** and towards the opposite side wall **214** such that the water flows from the first side wall **214***a* to the second side wall **214***b* and exits the pan **201** through an opening **206** in the inner wall of the pan **201** that is adjacent to the second side wall **214***b*.

As shown in FIGS. **18***a* and **18***b*, in one embodiment, the pan **201** may comprise extended drip ramps **206***c* that extend from the channel openings **206** in the inner wall of the pan **201**. In such an embodiment, the drip ramps **206***c* may extend towards the pole **301** such that water may exit the pan **201** through the openings **206** in the inner wall of the pan **201** and flow directly towards the pole **301** versus flowing towards the exterior of the lower tier of the pole cup **207**, as illustrated in FIG. **18***b*. In such an embodiment pan **201** may be positioned such that a gap exist between the drip ramps **206***c* and the bottom surface of the pole cup **305** allowing water to freely flow towards the pole **301** without any restriction.

The plurality of protrusions **202** extending upward from the base of the pan **201** may be located in between the interior of the side rails **209***a*, **209***b*. As shown in the Figures, in one embodiment, at least a portion of the protrusions **202** may be arranged in equally distanced rows that are parallel to the inner and outer walls (**212**, **213**, respectively) of the pan **201**, where the protrusions **202** are configured such that the roots of a plant are able to at least partially wrap around the protrusions **202** and anchor the plant during the growing process, for example when the hydroponic assembly **200** uses a tray **215**, as will be described in further detail later. In other embodiments of the invention, other vegetation such as wheat grass, or other types of similar vegetation may be grown within the base of the pan **201** between the protrusions **202**. The protrusions **202** may act as locations in which the seeds of various types of vegetation may be placed to provide support for keeping the seeds in place and not washing away with the flow of water. The plurality of protrusions may vary in height and/or width. In one embodiment, the height of any given protrusion **202** does not exceed above the height of the side rails **209***a*, **209***b*.

The pan **201** may comprise one or more hooks **208** that allow that pan **201** to be connected to a cup **305** on the pole **301**. It should be noted that the pan **201** may be connected to the pole assembly **300** using various coupling mechanisms or methods. As shown in FIG. **18** through FIG. **20**, in one embodiment, the coupling method is a hooking mechanism that allows the pan **201** to hook onto the upper tier **306** of the pole cup **305**. One or more hooks **208** may extend from the inner wall **212** of the pan **201** and hook onto the top edge of the upper tier **306** of the pole cup such that the inner wall **212** of the pan **201** is adjacent to the exterior of the pole cup **305**. In this regard, the inner wall **212** of the pan **201** may reflect the shape of the pole cup **305** such that it conforms to the pole cup **305** and is flush with the exterior surface of the pole cup **305**. For example, the inner wall **212** may have the same shape as the exterior surface of the upper tier **306** and lower tier **307** of the pole cup **305**. It should be noted that the pans **201** can be moved and spaced in a 360 degree orientation around the pole cup **305** and on different levels of the pole cups **305** to support different types of plants. For example taller tomato plants may have a pan **201** on a lower cup and no pan located above the tomato plant to allow the plant to grow, while lettuce may be grown in a pan **201** that also has lettuce pans above and below. This invention allows the mixing and matching of different configurations to grow any type of vegetation. As such the hydroponics assemblies **200** may further comprise clips that can clip onto the pan **201**, cup **305**, tray **215** or the like in order to support different types of plants. For example a clip (in some embodiments with a dowel to support the plant) may be used to support a tomato plant to grow vertically.

Although in the illustrated embodiments, a hooking mechanism is used to couple the pan **201** with the pole cup **305**, other means of connecting the two structures may be used in conjunction with the present invention. In one embodiment, as shown in FIG. **21**, the pan **201** may be connected directly to the pole **301** itself. As such, the pole may comprise several openings and/or exit slots **317** that are configured for receiving the hooks **208** of the pan **201** such that the hooks **208** are at least partially positioned within the interior of the pole **301**. In such an embodiment, the use of a spout **400** may be omitted from the design in order to transport water from the pole **301** to the pan **201**.

In the alternative, the hooks **208** may contain smooth groove or indentations at the top such that the water flows from the exterior of the pole **301** through the grooves within the hooks **208** and into the base of the pan **201**. In other embodiment the flow of water back down to the tank **101** may occur within the pole **21**, such that water is flowing upwardly through the pole **21** in a first chamber, such as the tube, and running back down the pole **21** in a second chamber, such as between the outside of the tube and the inside of the pole **21**. The hooks **208** may catch the water on the inside of the pole **301** and deliver it to the pan **201**.

In yet another embodiment, the pan **201** may be connected to the pole **301** via a spout **400**. The spout **400** may be permanently or removably coupled with the pole **301**. As shown in FIGS. **13**B and **13**C, in such an embodiment, the spout **400** may be embodied by a pole apron having a plurality of slits therein such that the pan **201** is positioned to rest adjacent to the top edge of the pole cup **305** and wedges underneath a portion of the pole apron such that it is securely positioned in place. The pan **201** may be additionally supported by a cantilever. In other embodiments, the pole apron may have a continuous perimeter wall and exclude the plurality of slits. In some embodiments, the wedge may hook into a portion of the pole **301** of the pole apron **400**. In an exemplary embodiment, at least a portion of the bottom surface of the pan **201** is flush with the top edge of the pole cup **305** to provide a means of stability. The water may then run down the pole **301** and down a top surface of the pole apron (spout **400**), optionally to the plurality of slits and/or through (in between) the slits, and into the pan **201**. As such the pan **201** may comprise an extended inner wall **212** that extends beyond the top surface of the side walls **214**, and the outer wall **213**, and defines a wedge that is configured to wedge beneath at least a portion of the pole apron (spout **400**) and fasten the pan **201** in a secure position. For example the pan **201** may be inserted in the spout **400** at an angle and lock into place using the wedge. In an exemplary embodiment the extended inner wall **212** (and/or wedge) may be ¼ inch in length. However, in other embodiment, the length of the extended inner wall **212** and the side walls in general may vary in lengths and/or widths. In some embodiments, the pan **201** may comprise an extended inner wall **212** that extends beyond the side walls **214** outward from the pole in a dovetail configuration, that is configured to horizontally slide into one or more slits within the pole apron **400**. In some embodiments, the system may comprise an additional reverse spout **400** that is connected to either the pole **301** and/or the pan **201** and configured to direct the flow of water from the pole apron **400** back into a pole cup **305** positioned beneath the pole apron.

As illustrated in FIGS. **25** through **27**, a grow tray **215** may be utilized along with the pan to grow different types of vegetation. The grow tray **215** may be defined by a tray that has a first and second members **216**, **217**, which are configured to be coupled with one another such that a plurality of interior tray channels **218** are formed therein. As shown in the illustrations, in one embodiment, the tray **215** may be further defined by walls that extend upward from the base of the tray **215**. The tray may comprise an inner wall **224**, an outer wall **225**, and two side walls **226***a*, **226***b* that collectively form an opening in the top of the tray **215**.

The first and second members **216**, **217**, respectively of the grow tray **215** may independently have a plurality of interior channels **218**. Each interior channel **218** of the first member **216** may have a channel edge **219** that is configured to be operatively coupled with a corresponding edge hole **221** of the second member **217**. Likewise, each interior channel **218** of the second member **217** may have a channel edge **219** that is configured to fasten into a corresponding fastening hold **221** of the first member **216**. The interior channels **218** may be parallel to one another with respect to the inner and outer walls (**224**, **225**, respectively) of the tray **215** such that when the first and second members (**216**, **217**, respectively) are coupled together a plurality of openings **223** is formed in the base of the tray **215**. The openings **223** may allow water to flow through the base of the tray **215** into a pan **201** positioned below the tray **215**. The tray **215** may additionally have at least one main channel **220**, where each of the main channel **220** may correspond to either the first or second member **216**, **217** of the tray **215** such that when water flows into the tray **215** it may either (a) flow directly through one of the openings in the base of the tray, or (b) flow down the main channel **223** and be dispersed throughout the interior channels **218**. In this regard each interior channel **218** may have an opening, opposite of the channel edge **219**, which is connected to and can receive water from the main channel **223**. Furthermore, the water may overflow out of the interior channels **218** and into the openings **223** between the interior channels **218**. As explained in further detail later the seeds of various plants may be located within the channels **223**, **218**. For example, rocks may be placed in the channels **223**, **218**, and the seeds may be placed in cotton balls between the rocks. The water flows over the seeds and down into the pan, and when the seeds grow the roots will reach down into the pan **201** through the openings **223** in the tray **215**. As further illustrated in FIG. **26**, the outer wall **225** of the tray **216** may optionally comprise one or more openings **225***a* that allow water to exit from the rear of the tray **216** and enter the pan **201** positioned below. In this way the openings **225***a* in the outer wall **255** of the tray **216** may prevent water from remaining stagnant within the tray after it is received from the pole assembly **300** and flows throughout the channels **228** within the tray **216**.

As illustrated in FIG. **19** and FIG. **20**, the shape of the tray **215** after the first and second members **216**, **217** have been coupled with one another may reflect the shape of the pan **201** such that the tray **215** can be placed within the pan **201**. It should be noted that although in the illustrated embodiments, the pans **305** and trays **215** are generally trapezoidal in shape, the pans **305** and trays **215** may be embodied by other shapes not illustrated herein, including but not limited to, cubed, rectangular, cylindrical, and/or organic or ameba shapes. To this extent, both the pan **305** and the tray **215** may have additional or excluded boundaries (e.g., inner walls, outer walls, sides walls) than what is contemplated herein. As shown in FIG. **13**D and FIG. **13**E, in some embodiments, both the pan **201** and the pole **301** may be rectangular and/or cubed in shape such that the pan **201** and the pole **301** comprise four (4) side walls wherein at least one side wall of the pan **201** is adjacent to at least one side wall of the pole **301**. Alternatively, the pan **201** and the tray **215** may be circular in shape such that they comprise a single continuous perimeter wall. In such an embodiment, the grow pan may receive water from the pole assembly at a first portion of the perimeter wall, and transfer the water to and/or towards a second portion of the perimeter wall.

When placed in the pan **201** at least a portion of the base of the tray **215** rests adjacent to the side rails **209** of the pan **201** such that the side rails **209** support and uphold the tray **215** after it has been placed within the pan. Furthermore, in a preferred embodiment, the length of the tray **215**, as defined by the distance between the tray's inner wall to its outer wall **224**, **225**, is less than the length of the pan **201**, as defined by the distance between its inner wall to the pan's outer wall **212**, **213**, such that the tray **215** is configured to slide along the side rails **209***a*, **209***b* back and forth between the inner and outer walls of the pan **213**, **214**. In this regard, the first member **216** of the tray **215** may have at least one handle **222** that a user of the aquaponics system may grip to aid in sliding the tray **215** back and forth within the pan **201**. In one embodiment, as shown in the Figures, the at least one handle **222** may be located at the top edge of the outer wall **225** of the tray **215**. When positioned on top of the side rails **209***a*, **209***b* towards the front of the pan **201**, the inner wall **224** of the tray **215** may be adjacent to the inner wall **212** of the pan **201**. When positioned on top of the side rails **209***a*, **209***b* towards the back of the pan **201**, the outer wall **225** of the tray **215** may be adjacent to the outer wall **213** of the pan **201**. The tray **215** may additionally be positioned, on top of the side rails **209**, in any area between the inner and outer walls of the pan **201**. In one embodiment, the top of the tray **215** may extend beyond the top of the pan **201** after being placed on the rails **209***a*, **26***b*. In another embodiment, the top of the tray **215** may be flush with the top of the pan **201** after being placed on the side rails **209***a*, **209***b*. In still other embodiments, the tray **215** may not sit within the pan **201**, and instead may be span the opening of the pan **201**. As will be explained in further detail later the tray may be moved from a first position near the spout **400** to collect water in the channels **218**, **220** or may be moved to a second position so instead of delivering water to tray **215** the water is delivered to the pan **201** (e.g., when the roots grow from the tray **215** into the pan **201**). In yet another embodiment, the tray **215** may be positioned within the pan **201** in a third position such that the water is simultaneously dispensed into both the tray **215** and the pan **201** from the pole assembly. In such an embodiment the spout **400** may be embodied by a split configuration such that it directs the flow of the water to multiple locations, where a portion of the water is dispensed into the tray **215** and a portion of water is simultaneously dispensed to the pan **201**. Alternatively, in such an embodiment, the tray **215** may be embodied by a split configuration such that it directs the flow of the water to multiple locations, where a portion of the water is dispensed into the tray **215** and flows throughout the tray **215**, and a portion of water is immediately dispensed from the tray **215** to the pan **201**, prior to flowing throughout the tray **215**. In a preferred embodiment, the tray **215** is separable from the pan **201** to allow the roots to grow into the protrusions **202** of the pan **201**. In such an embodiment, the tray **215** may be removed from its position above the side rails **209** of the pan and further disassembled such that the first and second members **216**, **217** are separated from one another and the tray is removed from the aquaponics system **1** without harming the roots of the plants.

In one embodiment of the invention the tray **215** is located parallel with respect to the ground such that water only flows out of the tray when the water overflows the channel **218**, **220** walls. In one embodiment, side rails **209***a*, **209***b* in the pan **201** may be sloped towards the outer wall **213** of the pan **201** such that when the tray **215** is positioned on top of the side rails **209** the tray **215** is similarly slopped towards the outer wall **213** of the pan allowing the water to flow from the inner wall **224** of the tray **215** to the outer wall **225** of the tray **215** and overflow into the pan **201** below through a gap that is created between the outer wall **225** of the tray **215** and the outer wall **213** of the pan **201**. The gap may allow water to flow off the top of the tray and into the pan **201**. The pan **201** may then be sloped towards the pole assembly **300** such that after the water enters the pan **201** the water flows towards the pole assembly **300** and exits the pan **201** through one or more openings **206** in the inner wall of the pan **201**.

FIGS. **28** through **30** illustrate a spout **400** in accordance with embodiments of the invention. As illustrated in FIG. **1**, water may be transported from the pole assembly **300** to the hydroponics assembly **200** using a spout **400**. As illustrated in FIGS. **28** through **29**, the spout may be defined by a planar surface **401** that extends upwards from one or more spout hooks **402**. The spout **400** may be hooked onto the pole cup **305** and/or the pan **201**, such that the spout **400** at least partially rest on the edge of the upper tier **306** of the pole cup **305**, or the top of the pan hooks **208**. As shown in FIG. **1**, in one embodiment, the pan may have three (3) hooks **208** that are equally spaced apart such that spaces are formed in between the pan hooks **208**. The spout **400** may then have two (2) hooks **402** that securely fit within the spaces formed in between the pan hooks **208** such that the spout is coupled with both the edge of the pole cup **305** and the pan **201** when the hooks **402** are positioned within these spaces of the pan hooks **208**. The planar surface **401** may then extend upwardly and inwardly from the inner wall of the pan **212** towards the pole **301** and/or exterior of the pole **301**, such that the water flows from the pole assembly **300** to the spout **400** and subsequently into the hydroponics system **20**. The top edge of the spout **400** may be adjacent to either the pole **301** and/or exterior of the lower tier **307** of the pole cup **305**. The bottom edge of the spout **400** may be adjacent to the top of the inner wall of the pan **201**. In one embodiment, as shown in the illustrations, at least a portion of the sides of the spout **400** may be elevated such that the elevated portion concentrates the flow of water towards the center of the spout **400**. In some embodiments, sides may extend the length of the spout **400** in order to prevent or reduce the amount of water that flows over the sides of the spout **400** and never makes it to the pans **201**. In one embodiment, the sizes of the spouts **400** may be varied in order to supply different amounts of water to the pans **201**. In some embodiments the spouts **400** may cover the circumference of the pole **301** up to at least ½, ⅓, ¼, ⅕, ⅙, ⅛, 1/16, 1/32, or the like of the circumference of the pole **301**. It should be understood that the various spouts **400** may cover any range of the circumference of the pole **301** that falls within, outside of, or overlap any range of circumferences of the pole **301** for these values. Spouts **400** of different sizes may be added or removed from the aquaponics system **1** in order to change the amount of water directed to one or more of the pans **201**.

In one embodiment, as shown in FIG. **1**, spouts **400** may be used to deliver water to the hydroponics assemblies **200**. In such an embodiment, water may either fill up in the pole **301**, or may be transported throughout the pole **301** and to the top of the pole **301** using an optional tube such that the water flows over the top edge of the pole or through one or more exit slots **313** in the pole assembly **300** where it is subsequently delivered to the hydroponics assemblies **200** via the spouts **400**.

In an alternative embodiment, as shown in FIG. **30**, puncture spouts **400** may be used to deliver water to the hydroponics assemblies **200**. In such an embodiment, the pole **301** may have a pole cap **312** installed that allows water to be released back into the tank **101** as pressure builds within the pole **301**. Additionally and/alternatively a spout **400** may be placed directly into the pole **301** such that it penetrates the outer layers of the pole **301** and allows water to enter into the spout **400** directly from the pole **301**. In such an embodiment, the spout **400** may additionally comprise a flow rate control value that varies the rate of flow of the water. For example, the flow rate control valve may be a ball or gate valve that comprises a hard flap to divert the water down the spout **400** towards the pan **201**. The spout **400** may then spread water into the pan **201** with a lower portion of the spout **400** that may be wider or narrower than the rest of the spout **400**. In one embodiment, where the spout **400** is directly coupled with the pole **301** such that it penetrates the outer layers of the pole **301**, the pole **301** may be formed of a material that has resealable properties such that the pole reseals itself after the spout **400** has been removed. In another embodiment, where the spout **400** is directly coupled with the pole **301** such that it penetrates the outer layers of the pole **301**, the pole **301** may have a plurality of pre-punctured holes configured to receive the spout **400** such that the pre-punctured holes may be covered with a cap when the spout **400** is not in use. This method may limit access to the pre-punctured hole when the spout is not in use thus restricting the continued flow of water from the pre-punctured hole.

It should be understood that the size of the aquaponics system **1** may vary depending on the end use of the aquaponics system **1**. As such, in one embodiment the aquaponics system **1** may be configured to fit on a countertop in a kitchen, school laboratory, or the like. In other embodiments, the aquaponics system **1** may be sized to fit in garages, greenhouses, or other like areas for a greater yield on the production rate of the vegetation. In still other embodiments of the invention, the aquaponics system **1** may be sized to fit within warehouses in which vegetation may be produced on a production level scale. In all of these systems different sizes of an aquaculture system **10** (e.g., tanks **101**) may be utilized with multiple pole assemblies **300** and multiple hydroponic assemblies **200** on an as needed basis in order to grow the desired amount of vegetation. For example, two poles **301** may be stacked on top of each other in order to extend the height of the aquaponics system **1** for growing more food. In other embodiments more hydroponics assemblies **200** are added to the pole **301** to grow more food. Any number of pole assemblies **300** and/or hydroponics assemblies **200** may be utilized to grow the desired amount of vegetation (e.g., food).

FIG. **31** illustrates an aquaponics system **1** in accordance with one embodiment of the present invention. As illustrated, in some embodiments, the system may comprise a plurality of pole assemblies **300**. In such an embodiment, the plurality of pole assemblies **300** and hydroponic assemblies **200** may be arranged in parallel and series with one another and connected via main pipelines **316**, **317**. In contrast to being directly coupled with a tank **101** of an aquaculture system **10**, the bottom of the one or more pole assemblies **300** may be connected to a mainline pipe **316** that transports water from an aquaculture system **10** to the pole assemblies **300**. For example, water may be pumped from aquaculture assembly **100** to the main supply pipeline **316**, throughout the pole assemblies **300** to the hydroponic assemblies **200**, return to the main return pipeline **317**, and subsequently to an aquaculture assembly **100** located nearby. In some embodiments, the main pipeline **316** may be used solely for structural support of the aquaponics system versus being used as a means to transport water to the pole assemblies **300**. As such in that embodiment the flow is delivered to the pole **301** through the use of a tube that runs inside of the pipeline **317** and also returns to the aquaculture assembly **100** through the pipeline **317**.

FIG. **32** illustrates a method **500** of assembling the aquaponics system **1**, in accordance with one embodiment of the invention. As illustrated in FIG. **14***a*, assembling the aquaponics system may comprise several steps, including but not limited to, coupling the pole assembly **300** with the aquaculture assembly **100** (**511**), and coupling the hydroponics assembly **200** with the pole assembly **300** (**512**).

As illustrated by block **311**, coupling the pole assembly **300** with the aquaculture assembly **100** may comprise receiving the bottom of the pole **301** within the recess **109** of the pole anchor **108** such that the pole assembly **300** extends upward from the base plate **107** of the tank **101** and is positioned in an upright orientation. In some embodiments a tube is inserted into the pole **301**, and secured within the pole **301** by securing the pole cap **312** to the tube and/or the pole **301**. The access notch **303** in the pole **301** (or a tube located therein) may be operatively coupled to a pump, which is used to pump water from the tank up through the pole **301**. In some embodiments, the pump is located outside of the tank **101** of the aquaculture assembly **100**; however, in other embodiments the pump is submerged within the tank **101** of the aquaculture assembly **100**.

Coupling the pole assembly **300** with the aquaculture assembly **100** may further comprise stabilizing the pole assembly **300** within the tank **101**. The pole assembly **300** may be stabilized by fastening a first end **121** of the strut **120** to the top edge of the upper tier **306** of a pole cup **305**, where the top edge of the upper tier **306** of the pole cup **305** is flush with the tank opening perimeter **105**, and fastening a second end **122** of the strut **120** to a ridge **106** located on the outer perimeter of the tank **101**. A plurality of struts **120** may be used to stabilize the pole assembly **300** within the tank **101**. For example, as shown in the illustrated embodiments, three (3) struts **120** are used to stabilize the pole assembly **300** within the tank **101**. After the struts **120** have been positioned in place, the aquaculture assembly **100** may be further assembled by positioning one or more tank covers **114** at the opening of the tank **105**, where the tank covers **114** may be at least partially received within one or more indentations

123 in the top surface of the struts 120. The pole assembly may be further assembled by positioning the pole cap 312 at the top of the pole 301.

As illustrated by block 512, coupling the hydroponics assembly 200 with the pole assembly 300 may comprise operatively coupling (e.g., attaching, or the like) one or more grow pans 201 to the pole assembly 300. In one embodiment, the grow pans may be attached to the top edge of the upper tier 306 of a pole cup 305, where the grow pans 201 are hooked onto the top edge of the upper tier 306 of a pole cup 305 using one or more pan hooks 208. Depending on the type of vegetation being grown, the hydroponics assembly 200 may be further assembled by optionally placing a tray 215 within at least one grow pan 201, such that the tray 215 rests on the side rails 209 of the pan 201. The pan 201 may be utilized by itself to grow some vegetation, such as wheat grass, or other types of vegetation that require a constant or almost constant moving water supply. Alternatively, some seeds require an initial constant supply of water, and then require feeing water to only the roots of the vegetation, and as such the tray 215 may be utilized for this type of vegetation. Coupling the hydroponics assembly 200 with the pole assembly 300 may further comprise attaching a spout 400 between each grow pan 201 and pole 301, in order to supply water to the pans 201 that require water.

FIG. 32 illustrates a method 520 of utilizing the aquaponics system 1, in accordance with one embodiment of the invention. As illustrated in FIG. 32, utilizing the aquaponics system may comprise several steps, including but not limited to, filling the tank 101 of the aquaculture assembly 100 with water or another aqueous solution (521), placing a plurality of marine creatures within the tank 101 of the aquaculture assembly 100 (522), transporting the water from the tank 101 of the aquaculture assembly 100 to the pole assembly 300 (523), dispersing the water throughout the pole assembly 300 (524), receiving the water in at least a portion of the hydroponics assembly 200 via a spout 400 (525), returning the water from the hydroponics assembly 200 to the pole assembly 300 (526), and dispersing the water from the pole assembly 300 back to the tank 101 of the aquaculture assembly 100 (527).

In block 325, transporting the water from the tank 101 of the aquaculture assembly 100 to the pole assembly 300 may further comprise providing a pump within the tank 101 that pumps water from the tank 101 directly to the pole 301, or indirectly to the pole 301 using an optional tube at least partially located within the pole 301 and connected to the pump. In block 324, dispersing the water throughout the pole assembly 300 may further comprise dispersing water from the interior of the pole 301 to the exterior of the pole assembly 300. In one embodiment, this may comprise the water exiting the interior of the pole 301 through one or more exit slots 313 in the pole cap 312. As pressure builds in the pole, the water may flow out of one or more exit slots in either the pole 301 or the pole cap 312 such that the water flows out of the exit slots 313 and down the pole 301 onto a spout 400 or a pole cup 305 below. The water may flow down the exterior of the pole assembly 300, where at least a portion of the water is diverted by the spout 400, and further dispersed to the hydroponic assemblies 200. To this extent, in block 525, the hydroponics assemblies 200 may receive the water from the spout 400 such that the water flows throughout the pan 201, and optionally the tray 215, of the hydroponics assemblies 200 and down at least one channel 206 in the grow pan 201. The water may then exit the pan 201 through a channel opening 206 at the end of the channel and return to the pole assembly 300. Water that is being initially dispersed from the openings of the pole cap 312 or is being returned after circulation throughout the hydroponics assemblies 200 may then, in block 527, be dispersed back to the tank 101 of the aquaculture assembly 100. Dispersing the water from the pole assembly 300 back to the tank 101 of the aquaculture assembly 100 may further comprise controlling the rate of flow of the water as it returns to the tank 101 of the aquaculture assembly 100. This may be achieved by directing and/or distributing the water through a plurality of blades 311 located in the lower tier 307 of the pole cups 305 such that the orientation of the blades 311 may alter the rate of flow of the water. This process may continuously be repeated to supply the seeds, plants, or other vegetation with a constant supply of water.

Referring to FIG. 33, the benefit of aquaponic based systems is the majority of nutrients needed for healthy plant 630 growth are supplied by the fish 602 (or other organism living in the tank). Additionally, the plants 630 provide a means of removing contaminants that would cause injury to the fish 602. Thus, the plants 630 and the fish 602 are in a symbiotic relationship to help the other.

One of the major nutrients required for healthy plant growth is Nitrogen. In hydroponic systems, Nitrogen is added on a regular basis in the form of liquid fertilizers. However, in aquaponic systems, the nitrogen is supplied from fish waste 602 and other organic matter 604. Nitrogen is introduced into the system as Ammonia 606 (NH_3) and Ammonium 608 (NH_4+). The ratio 610 of Ammonia 606 and Ammonium 608 in a system is dependent on several factors, but mainly pH. At lower pH levels, the concentration of Ammonium 608 is greater than the concentration of Ammonia 606. At higher pH levels, the concentration of Ammonia 606 is higher than the concentration of Ammonium 608. Ammonium 608 is not necessarily toxic to the fish 602 and plants 630, and high concentrations of Ammonium 608 will have little effect on the plant 630 and fish 602 populations. Ammonia 606, on the other hand, can be toxic if present in high concentrations. Therefore, controlling pH in an aquaponic system may be important in order to keep the concentration of Ammonia 614 in the system at safe levels for the survival of both the fish 602 and the plants 630.

Even though Ammonium 608 is not necessarily toxic to either fish 602 or plants 630, the plants are not capable of absorbing the nitrogen from the Ammonium 608 in a manner that is productive for healthy plant 630 growth. In order to provide nutrients to the plants 630, the Nitrogen must be supplied in the form of Nitrates (NO_3^-) 620. Nitrates 620 are formed using a process called Nitrification 612 in which Ammonia 606 is transformed into Nitrates 620. Nitrification 612 occurs in two steps. The first step, named Ammonia Oxidation 614, converts Ammonia 606 into Nitrites 620 (NO_2^-) by the aid of bacteria known as Ammonia Oxidating Bacteria (AOB) 618.

$$NH_3+O_2 \rightarrow NO_2^-+3H^++2e^-$$

In the second step, named Nitrate Conversion 622, Nitrites 612 are converted into Nitrates (NO_3^-) 624 by the aid of bacteria known as Nitrogen Oxidating Bacteria (NOB) 624.

$$NO_2^-+H_2O \rightarrow NO_3^-+2H^++2e^-$$

The bacteria necessary for Nitrification 612 is found in nature. In a mature system, both types of bacteria can be found in healthy populations and the two stages of the Nitrification process work seamlessly to convert Ammonia 606 into Nitrates 626. However, in newer systems, even though the bacteria are naturally introduced into the system, the bacterial introduction rate is slow and therefore the bacterial population in the new system will be relatively low. The bacterial population will increase as the food supply for the bacteria increases. However, since the bacteria introduction rate is typically slower than the rate at which the bacterial food is introduced in the system, Ammonia **606** may not be converted at a sufficient rate to minimize the harmful effects of the Ammonia **606**. High Ammonia **606** levels can be minimized using a feed and bleed method in which system water that is high in Ammonia **606** concentration is replaced by fresh water.

As Ammonia **606** is introduced, AOB **618** is attracted to the system which starts the conversion of Ammonia **606** to Nitrites **620**. At this point, Ammonia **606** levels will begin to be regulated by Ammonia Oxidation **614**. However, even though the Ammonia **606** levels may remain in check, the dangers to the fish **602** may increase. As Ammonia **606** is toxic to fish, Nitrites **620** provide a further level of danger. Nitrites **620** displace Oxygen in the blood of the fish. In high concentrations of Nitrites **620**, the fish blood is incapable of carrying Oxygen to vital organs and the fish dies. Therefore, as AOB **618** levels increase in a new system, Nitrite **620** levels must be minimized until a sufficient population of NOB **624** is introduced into the system. Nitrite **620** levels can be minimized using the same feed and bleed method to minimize Ammonia **606**.

After the system has reached a critical mass of both AOB **618** and NOB **624** types of bacteria, both Ammonia **606** and Nitrite **620** levels, with the exception of some abnormalities, will remain regulated. AOB **618** will convert Ammonia **606** into Nitrites **620** and NOB **624** will convert Nitrites **620** into Nitrates **626**. The Nitrates **626** become a supplement for healthy development of the plant **630**, which the plant **630** absorbs through the roots **632** and in turn removes the Nitrates **620** from the system. This method is called Assimilation **628**. In addition to the bacterial populations present in the system, the Nitrification **612** and Assimilation **628** rates may vary dependent on several other factors.

One factor that affects Nitrification **612** is the concentration of Ammonia **606** in the system. At Ammonia **606** concentration increases, the Nitrification **612** rate increases. As was introduced above, high concentrations of Ammonia **606** present a harmful environment for both fish and plant life and must be minimized. Therefore, the harmful effects of the Ammonia **606** and the benefits of a high Nitrification **612** rate must be balanced. Also presented above is a method for controlling Ammonia **606** concentrations by controlling pH in the system. By controlling pH, Ammonia may be converted into Ammonium **608**, and a balance may be achieved in which the harmful effects of Ammonia **606** may be minimized and the Nitrification **612** rate may be maximized.

Another factor that affects Nitrification **612** rate is the concentration of Dissolved Oxygen **616** in the system. Oxygen **616** is a necessary element for Ammonia Oxidation **614** to occur and when Oxygen **616** concentration is low in the system, Nitrification **612** rate will slow. In Nitrite Conversion **622**, Oxygen **616** is supplied via a water molecule. In addition to promoting Nitrification **612**, Oxygen **616** is also a necessary element for the health of the fish **602** population. Generally in aquaponic systems, it is desirable to maximize the amount of fish **602** that a system can sustain. The fish **602** population will compete for Oxygen **616** that is necessary for Ammonia Oxidation **614**. Oxygen **616** is naturally introduced into the system through the atmosphere; however, such introduction rate is generally insufficient to sustain both a healthy fish **602** population and aid in Nitrification **612**. Therefore, as Nitrification **612** occurs, Dissolved Oxygen **616** levels in the system decrease and results in insufficient Oxygen **616** for the fish **602**. As a result, the system will become incapable of sustaining a large fish population **602**. In order to offset the effects of Oxygen **616** being removed from the system, Oxygen **616** must be introduced into the system using other methods such as using an air pump with a bubbler or an air stone. Additionally, Oxygen **616** can be introduced into a system by using a waterfall technique.

In addition to factors that affect the Nitrification **612** rate, there are several factors that affect the Assimilation **628** rate, which is the rate at which a plant absorbs Nitrates **626** through its roots **632** and in effect removes the Nitrates **626** from the system. One factor that affects Assimilation **628** is the concentration of Nitrates **626** in the system. As Nitrate **626** concentration increases, Assimilation **628** rate increases. Additionally, other factors that affect Assimilation **628** are factors that also affect healthy plant **630** growth such as the ability of the plant **630** to perform photosynthesis.

In a well regulated system, the Nitrification **612** process in seamless, the fish **602** population is healthy and grow at a maximized rate, and the plants **630** develop in a maximized rate. Typically, the absence of any one of these factors is evidence of an abnormality in the system. One typical abnormality is an unregulated source of Ammonia **606**. Stated above, both fish waste and the decomposition of organic matter **604** are sources for Ammonia **606** and Ammonium **608** in a system. Typically, Ammonia **606** introduced into the system by the fish **602** population is insufficient to cause an abnormality. The abnormality is usually introduced by the decomposition of organic matter **604** such as a dead and decaying fish or other organic matter such as fish food. Any food not uneaten by the fish **602** sinks and begins to decompose, releasing Ammonia **606**. High amounts of waste food in the system will lead to abnormally high levels of Ammonia **606** that cannot be regulated through the Nitrification **612** process. Therefore, feed rates must be monitored in order to prevent unregulated Ammonia **606** levels but at the same time sustain a maximized growth rate of the fish **602**. In cases where Ammonia **606** levels cannot be controlled, organic matter **604** must be removed from the system and Ammonia **606** concentration levels reduced either through pH control or by performing a feed and bleed on the system.

As stated above, a feed and bleed is the replacement of system water with fresh water. This has the effect of removing harmful items from the system. However, the feed and bleed also has the effect of removing beneficial items from the system such as AOB **618** and NOB **624** types of bacteria. Therefore, after a feed and bleed on the system is performed and AOB **618** and NOB **624** populations reduced, the rate at which Nitrification **612** is performed is reduced. As such, Ammonia **606** levels may increase and subsequent feed and bleeds will be required. This results in a down spiral in which the AOB **618** and the NOB **624** populations are destroyed and Nitrification **612** ceases. Feed and bleed methods for controlling concentration levels should be minimized and other methods should be employed such as controlling pH.

The end goal of any aquaponic system is to promote the introduction and sustainability of a critical mass of bacteria necessary for successful Nitrification **612** in the system. This in turn will lead to a system that is well regulated and provide for maximized plant **630** and fish **602** growth.

Using the aquaponics system **6** illustrated in the present invention may increase the growth rate of the vegetation by a factor of two over traditional farming techniques and increase the density of the growth of vegetation within an area by a factor of five over traditional farming techniques. In some embodiments, dependent on the type of vegetation the growth rate and/or the density of the vegetation may be less or more than these factors.

In some embodiments of the invention the aquaponics system of the present invention may be used strictly as a hydroponics system in which the fish are not utilized within the tank or the tank is substituted with a water supply. The tank or water supply in a hydroponics system may need nutrients or other plant feed components in order for the plants to properly grow. As such, the tank or the water supply may be supplemented with additional nutrients or other plant feed in order to grow healthy plants.

In one embodiment, the majority of water in the system is contained in the tank. Ammonia is introduced into the system through fish living in the tank and the decomposition of organic material. The water in the system contains all other elements necessary for Nitrification to take place. An operator analyzed the water on a frequent basis to ensure healthy levels of pH, Ammonia, Nitrites, and Nitrates. The operator adjusts pH as necessary using chemical additions to maintain pH at a healthy level. The operator will also maintain chemistry to of other elements to keep elemental concentrations within safe parameters. Bacteria in the system convert the Ammonia into Nitrites and then into Nitrates using the Nitrification process. The Nitrification process does not occur all at once, and therefore, each element of the Nitrification process may be present in the water. Nitrification is not limited only to the tank but can occur in any part of the system. Water flows through the system as follows: a pump moves the water from the tank, up the pole, and deposits the mixture in the trays; the water passes over either the seeds or the roots of the plants where assimilation occurs; the water is gravity drained back into the tank. As the plants perform assimilation, the Nitrates are removed from the system. In addition to removing Nitrates, the plants will also remove other elements that are in the system.

While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements shown and described, since various other changes, combinations, omissions, modifications and substitutions, in addition to those set forth in the above paragraphs, are possible. Those skilled in the art will appreciate that various adaptations, modifications, and combinations of the just described embodiments can be configured without departing from the scope and spirit of the invention. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described herein.

Also, it will be understood that, where possible, any of the advantages, features, functions, devices, and/or operational aspects of any of the embodiments of the present invention described and/or contemplated herein may be included in any of the other embodiments of the present invention described and/or contemplated herein, and/or vice versa. In addition, where possible, any terms expressed in the singular form herein are meant to also include the plural form and/or vice versa, unless explicitly stated otherwise. Accordingly, the terms “a” and/or “an” shall mean “one or more,” even though the phrase “one or more” is also used herein.

What is claimed is:

1. A system for growing vegetation, the system comprising:

a pole assembly comprising a pole and two or more hydroponic assembly coupling locations, wherein at least two of the two or more hydroponic assembly coupling locations are located at different vertical locations spaced apart on the pole, wherein each of the two or more hydroponic assembly coupling locations comprise:

a pole cup operatively coupled to the pole, wherein the pole cup comprises an upper tier and a lower tier, wherein both the upper tier and lower tier encircle the pole, wherein the pole cup has one or more apertures, and wherein the pole cup is configured to receive water from outside the pole into the upper tier of the pole cup and directs the water through the lower tier of the pole cup outside the pole;

a water supply operatively coupled to the pole assembly;

a plurality of hydroponic assemblies, wherein each of the plurality of hydroponic assemblies comprise:

a grow pan comprising:

a perimeter wall comprising a first wall portion adjacent the pole and a second wall portion located distal from the pole; and

two or more channels within the grow pan;

wherein a first channel of the two or more channels receives the water adjacent the first wall portion and transfers the water to adjacent the second wall portion; and

wherein a second channel of the two or more channels receives the water adjacent the second wall portion and transfers the water to adjacent the first wall portion;

wherein at least one of the plurality of hydroponic assemblies comprises a tray operatively coupled to the grow pan that is configured to support seeds or the vegetation;

wherein the grow pan of each of the plurality of hydroponic assemblies are configured to be removeably operatively coupled to the pole cup of any of the two or more hydroponic assembly coupling locations such that the grow pan of each of the plurality of hydroponic assemblies may be located at different hydroponic assembly coupling locations located vertically on the pole or around the pole at one of the different hydroponic assembly coupling locations;

wherein the water is directed into first grow pans, travels past the seeds or the vegetation supported in the first grow pans or one or more trays and thereafter is directed out of the first grow pans into a first pole cup outside of the pole, is directed through the one or more pole cup apertures of the first pole cup to second grow pans, travels past the seeds or the vegetation supported in the second grow pans and thereafter is directed out of the second grow pans to a second pole cup outside of the pole; and

wherein flow of the water through the first grow pans, the second grow pans, the first pole cup, and the second pole cup occurs outside of the pole and allows the water to travel around the seeds or the vegetation located in the first grow pans and second grow pans.

2. The system of claim **1**, wherein each of the plurality of hydroponic assemblies have a generally trapezoidal shape to allow the plurality of hydroponic assemblies to couple around an entirety of a circumference of the pole assembly.

3. The system of claim **1**, wherein the two or more hydroponic assembly coupling locations each comprise an apron operatively coupled to the pole or the pole cup, and wherein the plurality of hydroponic assemblies are operatively coupled to the apron or the pole cup.

4. The system of claim **1**, wherein the first channel or the second channel of the grow pan includes a base and has a plurality of protrusions operatively coupled to the base of the grow pan and extending upward from the base of the grow pan, and wherein the plurality of protrusions restrict movement of the seeds or the vegetation while allowing the water to travel around the seeds or the vegetation.

5. The system of claim **1**, wherein the grow pan further comprises rails, wherein the tray is positioned along the rails, and wherein the tray is configured to slide along the rails to deliver the water to the tray or the grow pan in at least two positions.

6. The system of claim **1**, wherein the first wall portion is an inner wall and the second wall portion is an outer wall, and wherein perimeter wall further comprises side walls operatively coupled the inner wall and the outer wall.

7. The system of claim **1**, wherein the first channel or the second channel includes a base, and wherein the base of the grow pan is sloped towards or away from the pole assembly.

8. The system of claim **1**, wherein the water exits the grow pan via an opening in the first wall portion of the grow pan.

9. The system of claim **1**, further comprising an aquaculture assembly, wherein the aquaculture assembly comprises:

a tank having a pole anchor located therein, wherein the pole anchor is configured to receive a bottom portion of the pole;

a plurality of struts configured to stabilize the pole within the tank; and

at least one tank cover positioned at an opening of the tank.

10. The system of claim **1**, further comprising:

one or more spouts, wherein each of the one or more spouts are configured to deliver the water from the pole assembly to each of the plurality of hydroponic assemblies.

11. The system of claim **1**, wherein the pole assembly further comprises:

a tube within the pole assembly;

a pole cap operatively coupled to the tube and the pole assembly and comprising one or more exit slots; and

wherein the water exits the pole assembly via the one or more exit slots, and wherein the pole cap increases water pressure within the tube.

12. The system of claim **1**, wherein the lower tier is narrower than the upper tier.

13. The system of claim **1**, wherein the upper tier is angled towards the lower tier to allow the water to flow towards the lower tier.

14. The system of claim **1**, further comprising a pump configured to pump the water throughout the pole assembly.

15. A system for growing vegetation, the system comprising:

a pole assembly comprising a pole and one or more hydroponic assembly coupling locations, wherein each of the one or more hydroponic assembly coupling locations comprise:

a pole cup operatively coupled to the pole, wherein the pole cup comprises an upper tier and a lower tier, wherein both the upper tier and lower tier encircle the pole, wherein the pole cup has one or more apertures, and wherein the pole cup is configured to receive water from outside the pole into the upper tier of the pole cup and directs the water through the lower tier of the pole cup outside the pole;

a water supply operatively coupled to the pole assembly;

a plurality of hydroponic assemblies, wherein each of the plurality of hydroponic assemblies comprise:

a grow pan comprising:

a perimeter wall comprising a first wall portion adjacent the pole and a second wall portion located distal from the pole; and

two or more channels within the grow pan;

wherein a first channel of the two or more channels receives the water adjacent the first wall portion and transfers the water to adjacent the second wall portion; and

wherein a second channel of the two or more channels receives the water adjacent the second wall portion and transfers the water to adjacent the first wall portion;

wherein at least one of the plurality of hydroponic assemblies comprises a tray operatively coupled to the grow pan that is configured to support seeds or the vegetation;

wherein the grow pan of each of the plurality of hydroponic assemblies are configured to be removeably operatively coupled to the pole cup of any of the one or more hydroponic assembly coupling locations around the pole at one of the one or more hydroponic assembly coupling locations;

wherein the water is directed into the grow pan of the plurality of hydroponic assemblies, travels past the seeds or the vegetation supported in the grow pan or the tray of the plurality of hydroponic assemblies and thereafter is directed out of the grow pan of the plurality of hydroponic assemblies into the pole cup and through the one or more pole cup apertures of the of the one or more hydroponic assembly coupling locations outside of the pole; and

wherein flow of the water through the grow pan of the plurality of hydroponic assemblies and the pole cup of the of the one or more hydroponic assembly coupling locations occurs outside of the pole and allows the water to travel around the seeds or the vegetation located in the grow pan of the plurality of hydroponic assemblies.

16. The system of claim **15**, wherein each of the plurality of hydroponic assemblies have a generally trapezoidal shape to allow the plurality of hydroponic assemblies to couple around an entirety of a circumference of the pole assembly.

17. The system of claim **15**, wherein the first channel or the second channel of the grow pan includes a base and has a plurality of protrusions operatively coupled to the base of the grow pan and extending upward from the base of the grow pan, and wherein the plurality of protrusions restrict movement of the seeds or the vegetation while allowing the water to travel around the seeds or the vegetation.

18. The system of claim **15**, wherein the first channel or second channel includes a base, and wherein the base of the grow pan is sloped towards or away from the pole assembly.

19. The system of claim **15**, further comprising an aquaculture assembly, wherein the aquaculture assembly comprises:

a tank having a pole anchor located therein, wherein the pole anchor is configured to receive a bottom portion of the pole;

a plurality of struts configured to stabilize the pole within the tank; and

at least one tank cover positioned at an opening of the tank.

20. The system of claim **15**, wherein the lower tier is narrower than the upper tier, and wherein the upper tier is angled towards the lower tier to allow the water to flow towards the lower tier.

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